Special Studies

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U.S. Army Corps of Engineers

Water Resources Support Center
Institute of Water Resources

Shoreline Protection and Beach Erosion Control Study

Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers

U.S. Army Institute for Water Resources
Policy and Special Studies Programs

The Corps of Engineers Institute for Water Resources (CEWRC-IWR) is part of the Water Resources Support Center in Alexandria, VA. It was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of tools and strategies needed to plan and execute Corps water resources planning.

IWR's program emphasizes planning concepts for use by Corps field offices. Initially, this work relied heavily on the experience of highly respected planners and theorists, gained in the many river basin and multiple purpose studies undertaken in the 1960's. As these concepts matured and became a routine part of Corps planning, the emphasis shifted to developing improved methods for conducting economic, social, environmental and institutional analyses. These methods were essential to implementation of the Water Resources Council's (WRC) Principles and Standards (P&S) and later, Principles and Guidelines (P&G) for water resources planning, which required a multi-objective analysis of and tradeoffs among national, economic and regional development, environmental quality and social effects.

Increasingly over the years, IWR has also responded to Corps program development needs by studying policy issues resulting from changes in national objectives and priorities. In addition to directly supporting Corps needs, IWR has established an analytic and strategic competence through participation in such efforts as the National Hydroelectric Power Resources and National Waterways Studies, the Water Supply and Conservation Research Program, the Social Impact Assessment Program, and as a lead participant in the National Council of Public Works Improvement's investigation of America's water resources infrastructure.

Many of these forward-looking policy and strategic studies were accomplished by the Policy and Special Studies Division. The mission of the Division is to support the Director of Civil Works by assessing and evaluating changing national water resources and related public works infrastructure management needs as they affect Corps Civil Works missions, policies, practices, legislative mandates, and executive directives.

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, WATER RESOURCES SUPPORT CENTER
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REPLY TO ATTENTION OF

June 24, 1994

CEWRC-IWR

MEMORANDUM FOR COMMANDER, Defense Technical Information Center, Cameron Station, Alexandria, VA 22314

SUBJECT: Transmittal of IWR Report 94-PS-1

1. Reference AR 70-31.

2. Two copies of IWR Report 94-PS-1, "Shoreline Protection and Beach Erosion Control Study - Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers", has hereby been submitted.

3. Initial distribution of this report has been made to appropriate Corps of Engineers agencies. It is recommended that copies of this report be forwarded to the National Technical Information Center.

4. Request for the DTIC Form 50 (Incl 2) be completed and returned to WRSC-IWR.

FOR THE DIRECTOR:

Enclosure

Kyle E. Schilling
Director

Shoreline Protection and Beach Erosion Control Study

Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers

prepared by

Shoreline Protection and Beach Erosion
Control Task Force
U.S. Army Corps of Engineers

for

The Office of Management and Budget

January 1994

IWR REPORT 94 - PS - 1

PREFACE

This report presents the initial phase of a study initiated in April 1993 in response to Fiscal Year 1994 budget "Passback Language" from the Office of Management and Budget, requesting an analysis of the Federal shore protection program with respect to costs, benefits, environmental effects and the related influences of shoreline development.

The purpose of this initial phase report is to provide early input to the Office of Management and Budget regarding: the scope of the Federal Civil Works shore protection program; a comparison of actual and estimated project costs; and estimates of the future costs of the shore protection program. The second phase of the study, which is currently underway, will include: additional analysis of the project costs; a comparison of actual versus anticipated benefits and environmental effects of the projects; an analysis of any induced development effects associated with the Federal shore protection program; and conclusions and recommendations.

ACKNOWLEDGEMENTS

In recognition of the importance of the request for information by the Office of Management and Budget, a task force of U.S. Army Corps of Engineers personnel and consultants with significant shore protection expertise was established to guide the effort and provide relevant information. Members of the Task Force are listed below.

Headquarters	Harry Shoudy, Chairman	
	Donald Barnes	John Housley
	Bill Hunt	John Lockhart
South Atlantic Division	Gerald Melton	
Jacksonville District	David Schmidt	
Wilmington District	Tom Jarrett	
North Atlantic Division	Edgar Lawson	
New York District	Lynn Bocamazo	
Philadelphia District	Christine McVey	
Waterways Experiment Station	Joan Pope	
Institute for Water Resources	Kyle Schilling	Eugene Stakhiv
	Ted Hillyer	Anne Sudar
	Lim Vallianos	Mike Krouse
	Christian Arellano	

The U.S. Army Institute for Water Resources was assigned the task of providing technical and management support to the task group. The staff of the Policy and Special Studies Division of the Institute for Water Resources provided the technical assistance, data collection and analysis for the Task Force. Mr. Ted Hillyer was project manager, assisted by Mr. Lim Vallianos, Ms. Anne Sudar and Mr. Christian Arellano. Dr. Eugene Stakhiv directed the effort as Chief of the Policy Division. The Director of the Institute for Water Resources is Mr. Kyle Schilling.

In addition to the individuals participating on the Shoreline Protection Task Force, significant contributions were made by: Dr. Wayne Young of the National Academy of Sciences' Marine Board; Mr. Todd Davidson and Mr. Michael Buckley of the Federal Emergency Management Agency; and Dr. Dave Nelson of the Waterways Experiment Station.

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EXECUTIVE SUMMARY

I. BACKGROUND

The U.S. Army Corps of Engineers is in the process of conducting a study to evaluate the economic and environmental effectiveness of the Federally sponsored shore protection and beach erosion control program. The study is being conducted in response to a request by the Office of Management and Budget.

The study is being performed in accordance with the following sequence of activities.

Phase I Effort - This part of the study defines the scope of the Federal shore protection program over the period 1950 - 1993 in terms of: the number of projects and related types of protective measures; lineal distances of protected shorelines; project costs and expenditures to date; and the quantities of sand used in the restoration and subsequent nourishment of beaches. This phase of the study also provides a projection of future costs of constructed projects requiring continued Federal involvement such as beach nourishment as well as an analysis of projected costs for authorized but unconstructed projects and for projects which are in the Preconstruction Engineering and Design (PED) stage. These projects have a strong possibility of being constructed in the next five to ten year period.

Phase II Effort - In Phase II, the study activities focus on the issues of benefits derived from the overall Federal shore protection program, the associated environmental effects, and on the question of whether or not shore protection projects induce development in coastal areas.

Final Report - The integrated results of the Phase I & II study efforts will be presented in a final report of findings and conclusions. The final report may also include an assessment of needs for policy changes in the Federal shore protection program.

II. FINDINGS TO DATE

1. SUMMARY. The portfolio of constructed Federally sponsored shore protection projects which are situated along various reaches of the Atlantic, Gulf, Pacific and Great Lakes shores, contains 82 specifically authorized projects of various types which span a composite shoreline distance of approximately 226 statute miles. Of the total 82 projects, 26 are very small in scope and cover only 16 of the 226 miles protected. These 26 small projects which cost a total of $4.56 million at the time of construction (approximately $175,400 per project), were eliminated from the detailed analysis.

Federal costs for the 26 projects amounted to $1.75 million (approximately $67,300 per project) or 38 percent of total costs.

The total investment in the remaining 56 large Congressionally authorized projects from 1950 to date, amounts to about $670.2 million, of which $403.2 million or 60 percent of total costs were provided by the Federal Government. The remaining $267.0 million or 40 percent of total costs were contributed by non-Federal sponsors. Projected Federal costs for the remaining currently authorized life of these 56 projects, in 1993 dollars, are $505.3 million.

In addition, there are presently 26 projects which are either authorized but unconstructed or are not authorized but are at the Preconstruction Engineering and Design (PED) stage which may be constructed over the next 5 to 10 year period. These projects in combination would cover a total shoreline distance of 151 statute miles. Total life-cycle costs associated with these projects, in 1993 dollars, are estimated to be $1,606.6 million. Based on a cost sharing percentage of 65/35, the Federal share of this cost would be $1,044.3 million in 1993 dollars.

Furtner, the U.S. Army Corps of Engineers is in the process of conducting studies to evaluate the feasibility of 15 separate projects that would provide protection to all or part of an additional 186 miles of shoreline.

A detailed synopsis of study findings to date is presented in the following paragraphs. This summarization of the study is presented in terms of: the scope of the Federal shore protection program; the actual total and Federal funds expended to date; a cost performance comparison of actual versus estimated costs, on a 1993 dollar basis; the comparative differences between the actual and estimated volumes of sand used in beach restoration and nourishment operations; anticipated expenditures for the remaining authorized life of the 56 large projects; and possible Federal costs for an additional 26 projects either authorized or in PED.

2. SCOPE OF CONSTRUCTED PROJECTS. The existing 82 Federal shore protection projects have been constructed in areas of concentrated development experiencing severe erosion and/or property damages attending storm tides and wave action. These projects span a combined distance of 226 miles. In relation to the total 84,240 miles of open ocean, estuarine, and Great Lakes shorelines in the United States, these projects protect only 0.3 percent of that total. If the State of Alaska's shorelines are excluded, these projects still represent only 0.6 percent of the remaining 36,940 miles of shore. Further, if the presently authorized but unconstructed projects and those currently not authorized but at the PED stage are assumed to be constructed within the next ten years, then the combined Federal project coverage by the year 2003 would increase to 377 miles, still only 0.5 percent of the total shoreline miles in the United States and 1.0 percent if the State of Alaska is excluded. Feasibility stage studies are also currently

investigating an additional 186 miles of coastline. From these comparisons, which are tabulated below, it is obvious that the Federal shore protection program since 1950 and for the next ten to twenty years has been and will continue to be limited to a very small portion of the nation's shorelines.

Type of Area	Miles of Shoreline	Percent of Total
Nation's Shoreline	84,240	100.0
Areas With No Significant Erosion	63,740	75.7
Areas With Non-Critical Erosion	17,800	21.1
Areas of Critical Erosion Not Covered by Federal Projects or Studies	2,137	2.5
Area Covered By Completed Federal Projects	226	0.3
Area Covered By Authorized Federal Projects and By Projects in PED	151	0.2
Area Covered By Authorized Federal Studies	186	0.2

3. FUNDS EXPENDED ON LARGE PROJECTS. The cumulative funds expended since 1950, on the 56 large shore protection projects have been disaggregated in accordance with the types of protection measures provided. The types of protection measures include: (a) sand fill for initial beach restoration; (b) sand fill for periodic beach nourishment; (c) structures such as groins, seawalls, breakwaters, etc.; and (d) emergency actions to repair various project features damaged by extreme storm events. The associated expenditures are tabulated below. As indicated, the average Federal share has been 60.2 percent.

	ACTUAL EXPENDITURES		
TYPES OF MEASURES	Federal Cost ($ million)	Federal Share (percent)	Total Cost ($ million)
Initial Beach Restoration	184.9	60.1	307.8
Periodic Beach Nourishment	143.0	61.9	230.9
Structures	59.4	51.4	115.6
Emergency Measures	15.9	100.0	15.9
TOTALS	403.2	60.2	670.2

The expenditures for the 56 projects adjusted to 1993 price levels are as follows:

TYPES OF MEASURES	ADJUSTED TO 1993 DOLLARS	
	Federal Costs ($ million)	Total Costs ($ million)
Initial Beach Restoration	430.2	735.0
Periodic Beach Nourishment	266.7	415.8
Structures	153.9	308.5
Emergency Measures	30.2	30.2
TOTALS	881.0	1,489.5

The procedure used for adjusting the costs of beach restoration and nourishment projects involved the volumes of sand placed and the current cost in each area for obtaining, transporting, and placing the sand at the respective project sites. Structural costs were adjusted by means of the Engineering News Record Construction Cost Index. A complete explanation of the cost adjustment procedure is contained in Chapter III of this report.

If all project costs were adjusted with the Construction Cost Index, the total cost of the 56 projects would be $1,177.3 million 1993 dollars.

4. COST PERFORMANCE ON LARGE PROJECTS. Estimated and actual costs for the 56 larger projects were adjusted to 1993 dollars so that cost estimating performance could be evaluated. There were 49 out of 56 large shore protection projects involving the use of sand fill for purposes of initial beach restoration, 40 involving periodic beach nourishment and 42 with a structural component. In order to present a meaningful evaluation, certain projects were not included in the comparative analysis due to the unavailability of complete cost data or because the constructed project differed from that envisioned at the time of the pre-construction estimate. The numbers of projects which had sufficient information to make a valid comparison of actual and estimated costs are given in the table below. Considering the program as a whole, the overall actual and estimated costs for those projects which could be compared, in 1993 dollars, are $1,340.9 million and $1,403.0 million, respectively. This shows that on average, actual costs have been less than estimated costs by four percent. A listing of actual and estimated costs and related ratios is presented below for the three basic types of protective measures.

TYPES OF MEASURES	NUMBER OF PROJECTS	Actual Costs ($ million 1993)	Estimated Costs ($ million 1993)	COST RATIO Actual/ Estimated
Beach Restoration	40 of 49	657.0	660.0	0.99
Beach Nourishment	33 of 40	385.3	431.6	0.89
Structures	35 of 42	298.6	311.4	0.96
TOTALS		1,340.9	1,403.0	0.96

5. COMPARISON OF ACTUAL TO ESTIMATED SAND VOLUMES. In addition to analyzing differences between actual and estimated project costs, a similar comparat analysis was performed to evaluate the differences between the actual and estima quantities of sand used in beach restoration and nourishment projects. As in the case of cost comparisons, the analysis of sand quantities, was confined to those projects with sufficient information to allow for valid comparisons.

In 39 of the 49 initial beach restoration projects, there has been an actual placement of 94.5 million cubic yards of sand compared to an originally estimated 93.7 million cubic yards. This results in an overall ratio of actual to estimated sand volume of 1.01.

In 33 of the 40 periodic nourishment projects, with a sufficient data base on sand quantities, there has been an actual placement of 72.5 million cubic yards of sand fill compared to an estimated 64.7 million cubic yards. Accordingly, the ratio of actual to estimated sand volumes amounts to 1.12. In some cases, the estimated average annual beach nourishment needs were revised over time in decision documents and coordinated with non-Federal sponsors to more appropriately reflect the experience of actual periodic nourishment performances and demands. Considering beach restoration and beach nourishment together, the actual volume of sand placed was five percent greater than the estimates. A listing of actual and estimated sand volumes and related ratios are presented below.

		VOLUMES OF SAND		
TYPES OF MEASURES	NUMBER OF PROJECTS EVALUATED	ACTUAL (million c.y.)	ESTIMATED (million c.y.)	VOLUME RATIO Actual/Estimated
Beach Restoration	39 of 49	94.5	93.7	1.01
Beach Nourishment	33 of 40	72.5	64.7	1.12
TOTALS		167.0	158.4	1.05

6. EXPECTED FUTURE COSTS OF COMPLETED PROJECTS. For the 56 large Congressionally authorized projects discussed in this report, the Federal share of future costs, in 1993 dollars, remains in the range of about $10 to $20 million per year until year 2027. After this time, Federal expenditures for the program progressively decline and reach a nil point by the year 2048. Total Federal expenditures over this future 54 year time period, in 1993 dollars, are estimated at $505.3 million. The expected distribution of Federal funds among the types of measures is shown in the following table. These projections assume that there will be no additional Congressional authorizations to extend Federal involvement in these projects.

TYPES OF MEASURES	REMAINING FEDERAL EXPENDITURES ($ millions 1993)
Beach Restoration	12.3
Beach Nourishment	477.4
Sand Bypassing Systems	15.6
TOTALS	505.3

7. POSSIBLE FUTURE COSTS FOR AUTHORIZED BUT UNCONSTRUCTED PROJECTS. There is currently one project under construction, ten projects which are authorized/awaiting initiation of construction and 15 other projects which are in the Preconstruction Engineering Design stage. The total life-cycle (50-year) cost for these 26 projects is currently estimated to be $1,662.5 million. Based on an assumed Federal share of 65 percent, Federal costs for these projects, in 1993, dollars would be $1,080.6 million. The distribution of these estimated future Federal costs, by project status, is shown below.

STATUS	NUMBER OF PROJECTS	ESTIMATED FEDERAL COST ($ million 1993)
Under Construction	1	9.7
Authorized/Awaiting Initiation of Construction	10	454.5
Preconstruction Engineering and Design	15	616.4
TOTAL	26	1,080.6

SHORELINE PROTECTION AND BEACH EROSION STUDY

PHASE I REPORT

COST COMPARISON OF SHORELINE PROTECTION PROJECTS

CHAPTER I - INTRODUCTION

1. AUTHORITY

This report has been prepared in response to the Fiscal Year 1994 budget "Passback Language" from the Office of Management and Budget. In the passback, the Office of Management and Budget requested that the Army initiate a shoreline protection and beach erosion study. Specifically, it was requested that:

> *"Army should conduct an analysis of the economic and environmental effectiveness of storm damage protection projects. The study should seek to compare and contrast the estimates of project benefits, costs, and environmental effects with current and projected conditions. The study should include a comparison of the anticipated and actual level of protection as well as an analysis of any induced development effects. The Office of Management and Budget should be consulted throughout the study process."*

2. SCOPE AND PHASING OF STUDY

This investigation applies to all Congressionally authorized or Federally sponsored studies and projects for shoreline storm damage protection and beach erosion control within the related program administered by the U.S. Army Corps of Engineers. Included are all beach nourishment projects (with and without groins) and sand bypassing operations as well as any other hard structures (seawalls, breakwaters, jetties, etc.) that were designed for shore protection and/or storm damage reduction. The overall study will be completed in two phases. The Phase I effort, reported herein, concentrated on gathering information related to project costs; i.e., what are the past and future Federal and non-Federal funding commitments for the shore protection program. The first phase also examined the locations and types of shore protection projects being constructed and studied and the miles of shoreline being protected by those projects. The second stage, which is currently under way, will include additional analysis of costs; a comparison of anticipated and actual benefits of the projects; an analysis of any induced development

effects; and conclusions and recommendations.

3. PLAN OF STUDY

a. Phase I - Cost Comparison. The first part of the Phase I effort consisted of a comprehensive collection and synthesis of relevant project data by means of a questionnaire (Appendix A) completed by the 22 Corps division and district offices having shore protection responsibilities. All costs in the tables are given as; estimated, actually expended, and adjusted to October 1993 price levels. The questionnaire also established a point of contact in each of the responding divisions and districts. A list of these points of contact is provided in Appendix B. The second part of the Phase I study involved information assimilation and analysis by means of computerized data base which, in addition to all of the cost data, yielded such information as the number of projects; project locations; types of projects in terms of protective measures; project status; project size with respect to miles of shoreline protected; dates of completed initial construction; quantities of sand used in beach restoration and nourishment; comparisons of actual and estimated costs; etc. This information was then put into tabular and graphic forms for report presentation. The final step of the first phase was the preparation of this report. This Phase I report constitutes an interim product, the purpose of which is to notify the Office of Management and Budget of the extent of the Federal Civil Works shore protection program and to present an overview of actual versus estimated cost comparisons and estimates of the future costs of the shore protection program. The data collected for this report will also be used as a basis to determine which projects will be selected for more detailed review in the Phase II study effort.

b. Phase II - Part One - Cost Performance Analysis. In this phase, the project cost performance versus the preconstruction estimates will be further analyzed. Additional analysis will be made to determine project performance and compare preconstruction estimates with historical costs and projected costs for the remaining life of the projects.

c. Phase II - Part Two - Benefit Performance. Project benefit performance will be evaluated for the categories of storm damage prevention, recreation, environmental impacts and level of protection. All projects identified in Phase I will be assessed. This study will utilize information readily available in district offices, Federal Emergency Management Agency reports, the Marine Board study on "Beach Nourishment Technology", etc. and from those Corps employees with a working knowledge of the projects. With respect to storm damage prevention, it must be recognized that most beach erosion control projects (excluding the hurricane protection projects), prior to the enactment of Public Law 99-662, the Water Resources Development Act of 1986 (WRDA '86), were not optimized for storm damage prevention but rather for recreation. Therefore, in the case of these projects it is not possible to compare actual to estimated

damage prevention benefits since such benefits were either not addressed or only partially evaluated in the authorizing documents. Due to the lack of available data, as well as funding and time constraints related to this study, only a select number of the older recreation based projects will be reanalyzed to determine their potential storm damage reduction benefits.

c. Phase II - Part Three - Evaluation of Induced Development. The question of whether or not development is induced by Federal shore protection projects will be examined by means of comparative evaluations. This will involve analyses of development rates, patterns and characteristics within select sets of protected and unprotected coastal areas which are otherwise comparable to the extent to which such similarity can be found.

e. Phase II - Part Four - Environmental. Environmental aspects of shore protection projects will be analyzed from a habitat and organism standpoint; potential benefits and detriments will be determined; management alternatives will be discussed and 5 to 10 case studies will be examined. From this, a summary and conclusions will be drawn with respect to environmental impacts of shore protection projects.

d. Final Report. The final report will integrate the results of the Phase I and II study efforts and will in addition, include an assessment of needs for policy changes in the Federal shore protection program. The final report is scheduled for submission to the Assistant Secretary of the Army for Civil Works in Fiscal Year 1994.

4. TASK FORCE

A task force comprised of shore protection evaluation experts from the U.S. Army Corps of Engineers Headquarters (HQUSACE), the North Atlantic and South Atlantic Division and District offices, the Waterways Experiment Station, the Water Resources Support Center, and consultants was established to assist in this study effort. The task force is chaired by the Policy Development Branch of Policy and Planning Division of the Directorate of Civil Works, HQUSACE. The task force was formed to assist in the development of the projects questionnaire, collection of cost data, refinement of benefit assessment and induced development methodologies, selection of projects for detailed review, provision of data and analyses of the effectiveness of storm damage protection projects, analysis of induced development effects of projects, and to meet on an as-needed basis to coordinate and review the effort. To date, the task force has met on three occasions in 1993 and once in 1994; i.e: 2-3 June, 9-11 August, and 4-5 November 1993 and 6 January 1994. All of the 1993 meetings were held at the Water Resource Support Center, Fort Belvoir, Virginia, whereas the 6 January 1994 meeting was conducted at the offices of the Corps Jacksonville District, Jacksonville, Florida.

5. BRIEFINGS

Briefings of the Assistant Secretary of the Army (Civil Works) (ASA(CW)) and the Office of Management and Budget (OMB) will occur periodically over the course of the study. To date, three briefings of the Acting ASA(CW) have occurred in 1993; 7 May, 21 September, and 10 November. There have been two briefings of OMB in 1993; on 1 June and on 23 December.

CHAPTER II - DESCRIPTION OF SHORE PROTECTION PROGRAM

1. FEDERAL INTEREST IN SHORE PROTECTION

a. Early History. Interest in shore protection began in New Jersey in the latter part of the 19th century and in the early decades of the 20th century. This stemmed primarily from the fact that the New Jersey shoreline, being within easy reach of the burgeoning populations of New York City and Philadelphia, was the first to experience intense beach-resort development and in turn problems arising from erosion and other storm effects. Millions of dollars were spent in New Jersey on uncoordinated and often totally inappropriate erosion control structures which often produced results that were minimally effective and in some cases, counterproductive. It was soon realized that the efforts of individual property owners were incapable of coping with the problem of coastal erosion and that a broader-based approach was necessary.

b. Organized Response. In response to the increasing problems of coastal erosion, the New Jersey legislature, in 1922, appropriated money for a formal investigation of the changes taking place along the state's coastline. At about the same time, a Committee on Shoreline Studies was formed under the Division of Geology and Geography of the National Research Council in Washington, DC. An outcome of the groups' activities in shore erosion matters was the formation of the American Shore and Beach Preservation Association. An early objective of this association was to induce the states to accept responsibility for their beaches. However, within a year of its formation in 1926, the association was lobbying to have the Federal government assume the function of unifying and coordinating the efforts of states with regard to shoreline problems. As a result, Congress enacted PL 71-520 in 1930. This law authorized and directed the U.S. Army Corps of Engineers to engage in shore protection studies in cooperation with state agencies and to establish a Beach Erosion Board. The Federal involvement in shore protection throughout the 1930's was essentially limited to cooperative analyses, planning studies and technical advisory services. These planning efforts were cost shared on an equal basis between Federal and non-Federal interests. With the onset of the Second World War, the U.S. Army Corps of Engineers' involvement in shore protection studies virtually ended as the agency was fully committed to the war effort.

c. Shift from Structures to Beach Nourishment.

(1). In the United States, as elsewhere prior to the Second World War, the main approach to the beach erosion and storm damage problems was through the use of fixed structures, usually groins, seawalls and jetties. These structures met with varying degrees of success. By the 1920's and 1930's, use of fixed structures had proliferated along certain resort sections of the Nation's coastline to such an extent that these

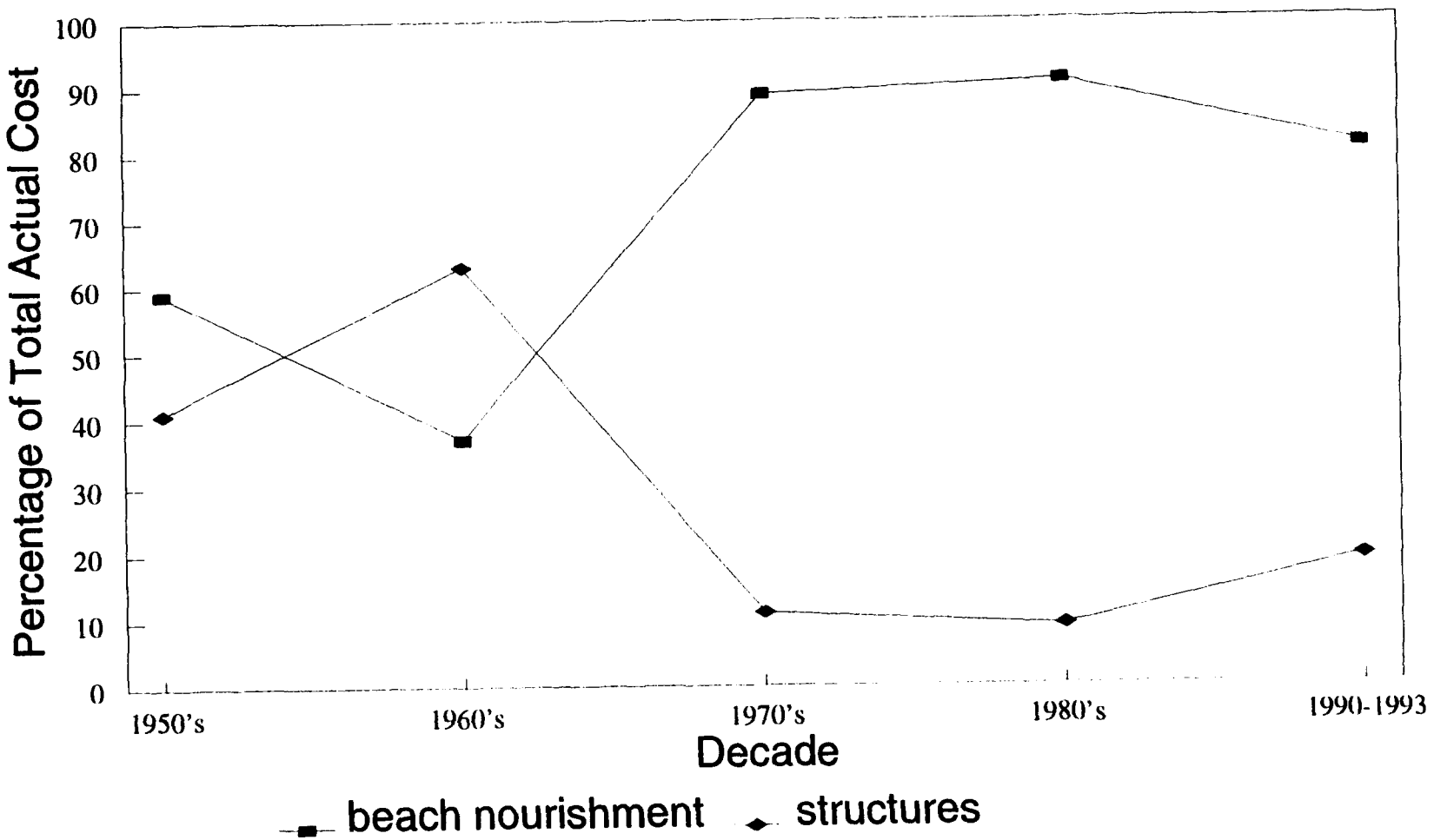
structures, while protecting both public and private property, impeded the recreational use of the beaches.

(2). In the late 1940's and early 1950's, an important change evolved in the basic concept of shoreline protection. Rather than solely relying on the traditional coastal defense structures of the past, it was increasingly realized that, in many situations, results would be more cost-efficient and functionally successful if techniques were used which replicated the protective characteristics of natural beach and dune systems. This concept, pioneered by the U.S. Army Corps of Engineers, placed emphasis on the use of artificial beaches and dunes as economically efficient and highly effective dissipators of wave energy. Other important considerations were the aesthetic and recreational values of artificially created beaches.

(3). The broad public acceptance which now exists in the use of artificial beaches as a primary means of shore protection was initially gained through Federal legislation related to beach renourishment; i.e., the recurrent need to replenish sand along a restored beach area. Until 1956, periodic nourishment was considered to be a form of maintenance, which was a totally non-Federal responsibility. In 1956, legislation was enacted which classified beach nourishment as a continuing construction feature, eligible for Federal cost sharing participation, when used as a substitute for other protective measures. The nourishment period recommended under the 1956 Act was generally for 10 years. Subsequent authorizations extended the period of Federal participation in beach nourishment. Federal participation was increased to 15 years in 1976 and to 50 years in 1986.

(4). The significant shift from a strong reliance on fixed structures to beach restoration and nourishment by the U.S. Army Corps of Engineers is demonstrated in Figure 1, wherein the initial restoration and periodic nourishment costs have been combined to show percent of costs spent on beach nourishment versus percent spent on structures. It will be noted that since 1960, the major proportion of funds expended on Federally sponsored shore protection projects has been associated with beach restoration and periodic nourishment.

Figure 1 - The Shift From Fixed Structures to Beach Restoration and Nourishment



d. Evolution of Federal Interest.

(1). The Federal responsibilities concerning shore protection were significantly expanded and consolidated through a series of 15 legislative acts beginning immediately following the Second World War. A chronological listing and summary of these acts is presented in Appendix C. This body of law has established an overall program in which the Congress has authorized Federal participation to prevent or control shore erosion caused by wind and tidal generated waves and currents along the nation's coasts and shores, and to prevent damage to property and loss of life from hurricanes and storm flooding. Participation includes research and development, planning, design, construction management and Federal cost sharing. Throughout the development of this Federal program, the responsibility for executing the program has been vested in the Secretary of the Army acting through the Chief of Engineers, U.S. Army Corps of Engineers.

(2). In the recent past, shore protection projects were traditionally developed for the purposes of shore (beach) erosion control, and/or hurricane protection. Beach erosion control projects provided for restoration of publicly-owned shores available for use by the general public. Private properties could be included if such protection and restoration was incidental to the protection of publicly-owned shores or if such protection would result in public use and benefits. Public use was defined as use by all on equal terms. For beach erosion control projects, study costs were 100 percent Federal; costs of construction were 50 percent Federal for non-Federal public shores; and 70 percent Federal for non-Federal public shore parks and conservation areas. Hurricane protection features were cost shared on the basis of 70 percent Federal and 30 percent non-Federal.

e. Water Resources Development Act of 1986.(WRDA '86).

(1). Section 103. With enactment of WRDA '86, Congress established hurricane and storm damage reduction as a project purpose to which costs should be assigned. Beach erosion control is no longer recognized as a project purpose, but subsection 103(d) specifies that the costs of constructing beach erosion control measures will be assigned to "appropriate" project purposes listed in subsections 103(a), 103(b), and 103(c), with cost sharing in the same percentage as the purposes to which the costs are assigned. The appropriate project purposes are hurricane and storm damage reduction (65/35 Federal/non-Federal) and recreation (50/50 Federal/non-Federal). Costs will be shared on these two purposes taking into consideration land ownership and public use. This act also requires a 50-50 cost sharing for feasibility studies.

(2). Section 933. Material dredged from navigation projects is recognized as a desirable potential source of material for beach nourishment. When placement of dredged material on a beach or beaches is the least costly acceptable means for disposal, the placement shall be considered integral to the navigation project and cost

shared accordingly. In those cases where placement of dredged material on a beach or beaches is more costly than the least costly alternative, Section 933 of WRDA '86, authorizes the Federal government to provide 50 percent of the costs greater than the least costly alternative providing all local cooperation requirements are met. In those cases where the additional costs for placement of the dredged material is not justified, the U.S. Army Corps of Engineers may still perform the work if the State requests it and non-Federal interests contribute 100 percent of the added cost of disposal.

(3). Section 934. Under Section 934 of WRDA '86, Federal aid for periodic beach nourishment at existing projects may be extended as necessary without further Congressional authorization for a period not to exceed 50 years from the date of start of project construction. The extension to 50 years is not automatic. After notification by the U.S. Army Corps of Engineers that the nourishment period is about to expire, the project sponsor must request an extension and express a willingness to cost share. A reevaluation for such projects will be made using current evaluation guidelines and policies. Section 934 authority will not be used to extend the period of authorized periodic nourishment of projects that use sand bypassing plants.

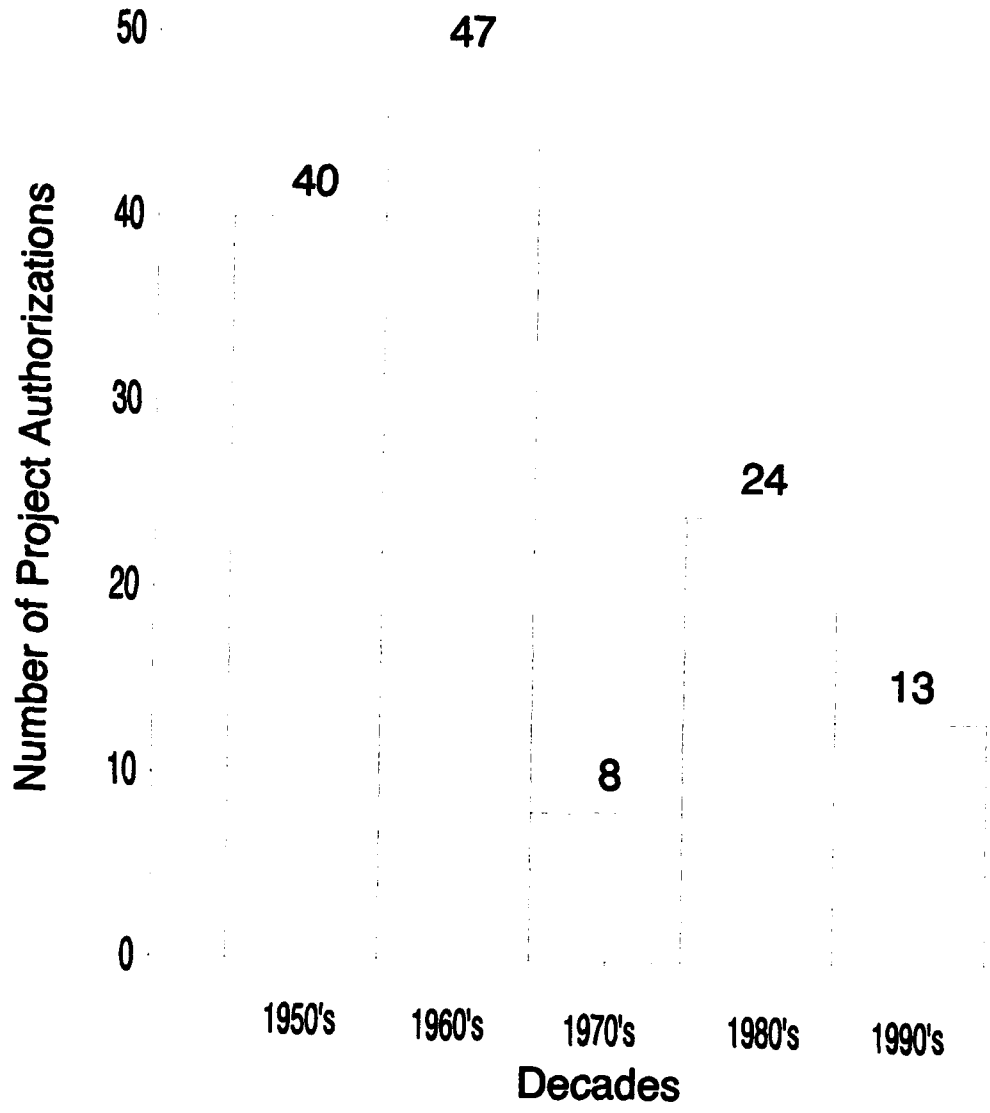
f. Historical Authorizations. Our study shows that since 1930, there have been 137 shore protection projects specifically authorized for some degree of Federal participation. A list of these Congressionally authorized projects and studies is provided in Appendix D. Prior to 1950, only five projects were authorized. During the 44 years since 1950, there have been 20 years when no projects were authorized and nine years when only one project was authorized. A high of 18 project authorizations occurred in 1954. Ten or more projects were also authorized in 1958(13), 1962(14), 1965(10), and 1986(17). The large number of projects authorized in the 50's and 60's was the direct result of the numerous major coastal storms that occurred during those years. The large number of projects authorized in 1986, as well as the low number of projects during the 1970's and early 1980's can be attributed to the lack of Water Resource Development Acts during the period of 1976 to 1986. Shown on Figure 2 is a graph of shore protection projects authorized over the 44 year period of 1950 through 1993.

g. Historical Construction Pattern. The historical construction pattern of completed beach restoration projects is shown in Figure 3. It will be noted that fewer projects are built than authorized, and the number of projects that are constructed, lag authorizations. In response to the large number of authorizations in the 50's and 60's, both the number of beach restoration projects completed and the volumes of sand placed increased during the 1960's and peaked in the 1970's. Due to lack of water resource authorizations in the 1970's, construction declined in the 1980's. In response to WRDA '86, the decade of the 90's has seen a resurgence of construction. There were as many projects completed in the 1990-93 period as there was during the entire decade of the 80's.

Figure 2

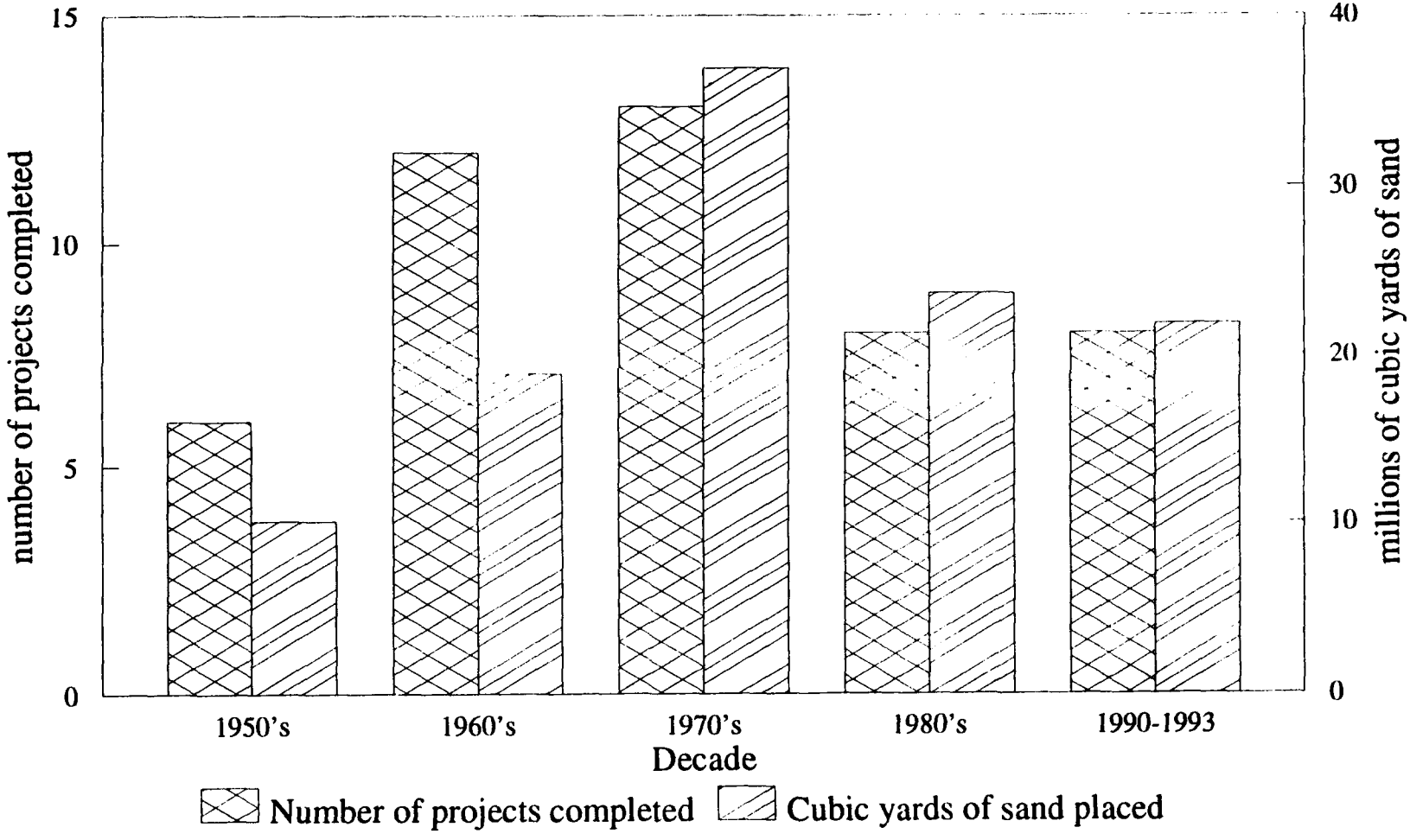
Historical Project Authorizations of

Shoreline Protection and Beach Erosion Control Projects



Note: Five projects were authorized prior to 1950

Figure 3 - Historical Pattern of Initial Beach Restoration



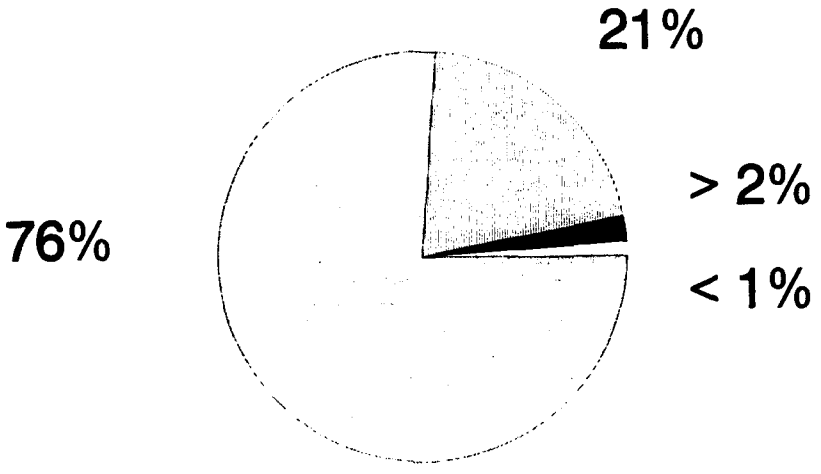
2. NATIONAL PERSPECTIVE

a. Overview. A national shoreline inventory was completed in 1971 and is documented in the National Shoreline Study, House Document No. 93-121, 93rd Congress, 1st Session, Volumes 1-5, June 29, 1973. This study showed there are about 84,000 miles of ocean, estuarine, and Great Lakes shorelines, including Alaska, Hawaii, Puerto Rico and the Virgin Islands. Of this total shoreline distance, 20,500 miles were identified as experiencing a significant degree of shore erosion. If Alaska is excluded, the Nation's shoreline distances amount to about 37,000 miles, of which 15,400 miles experience significant erosion. Of the 20,500 miles of shoreline that had significant erosion, 2,700 miles were identified as having critical erosion problems. Critical erosion was defined as "those areas where erosion presents a serious problem because the rate of erosion considered in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological, and other relevant factors, indicates that action to halt such erosion may be justified."

b. Results of Questionnaire. Based on the results of the study questionnaire, the U.S. Army Corps of Engineers has completed 82 specifically authorized shore protection projects covering 226 miles of shoreline. That equates to 0.3% of the total shoreline, 1.1% of the significant erosion areas and 8.4% of critical erosion areas. Another 41 projects and studies protecting an additional 337 miles of coastline are authorized but not yet constructed or are in the Preconstruction Engineering and Design (PED) stage. Figure 4 provides a perspective of the scope of the Federal shore program with respect to the Nation's shoreline. The values displayed in Figure 4 do not include projects implemented under the U.S. Army Corps of Engineers Continuing Authorities program for small projects or the numerous state, county, city, and private shoreline projects. The relatively few major Federal projects with respect to the total number of miles of shoreline experiencing critical erosion problems can, in part, be attributed to stringent Federal project feasibility criteria. These criteria, including benefit/cost analysis, virtually limit shore protection projects to densely developed areas with high economic value and public access.

Figure 4

Federal Program With Respect to Nation's Shoreline (84,240 miles)



Area covered by completed Federal projects
= 226 miles

Areas showing non-critical erosion
= 17,800 miles

Areas with no significant erosion
= 63,740 miles

Areas of critical erosion not covered by Federal projects
= 2,474

c. Regional Assessment. The bulk of the U.S. Army Corps of Engineers coastal projects are on the Atlantic coast. A regional perspective of project distributions is given in Table 1A. This project tabulation compares the number of completed projects and miles of coastline protected against the total miles of shoreline and the miles of shoreline with critical erosion problems as identified in the 1971 National Shoreline Study. Similarly, Table 1B gives the number and regional distributions of Corps projects and studies that are authorized or in PED, but not yet constructed. The length of shoreline protected includes reaches of coastline under study and in some cases this length will probably be reduced when actual projects are identified.

Table 1A

Regional Assessment of Completed Shore Protection Projects[1]

Region	Total[2] Shoreline Distance (miles)	Significant[2] Erosion Distance (miles)	Critical[2] Erosion Distance (miles)	Number of Projects	Protected Shoreline Distance (miles)
North Atlantic	8,620	7,460	1,090	41	77.4
South Atlantic-Gulf	14,620	2,820	980	22	107.0
Lower Mississippi	1,940	1,580	30	1	7.0
Texas Gulf	2,500	360	100	2	4.5
Great Lakes	3,680	1,260	220	6	14.8
Alaska	47,300	5,100	100	0	0.0
North Pacific	2,840	260	70	0	0.0
California	1,810	1,550	80	10	15.1
Hawaii	930	110	30	0	0.0
Total for Nation	84,240	20,500	2,700	82	225.8

Footnotes: 1 Does not include small shore protection projects in the Continuing Authorities Program

2 From the 1971 National Shoreline Study

Table 1B
Regional Assessment of
Authorized But Not Constructed Projects and Studies[1]

Region	Total[2] Shoreline Distance (miles)	Significant[2] Erosion Distance (miles)	Critical[2] Erosion Distance (miles)	Number of Projects/ Studies	Protected Shoreline Distance (miles)
North Atlantic	8,620	7,460	1,090	8	60.2
South Atlantic-Gulf	14,620	2,820	980	25	204.2
Lower Mississippi	1,940	1,580	30	0	0
Texas Gulf	2,500	360	100	1	8.0
Great Lakes	3,680	1,260	220	1	2.0
Alaska	47,300	5,100	100	1	0.2
North Pacific	2,840	260	70	0	0
California	1,810	1,550	80	5	62.3
Hawaii	930	110	30	0	0
Total for Nation	84,240	20,500	2,700	41	336.9

Footnotes:
1 Includes projects in PED but does not include shore protection projects/studies in the Continuing Authorities Program.
2 From 1971 National Shoreline Study.

3. PROJECT PURPOSES

a. Hurricane and Storm Damage Reduction. Section 103(d) of WRDA '86 established hurricane and storm damage reduction as a project purpose. Cost sharing for this purpose is 65 percent Federal and 35 percent non-Federal.

b. Recreation. Department of Army policy precludes the use of Civil Works funds for implementing recreation-oriented projects due to current budget deficits. Section 103 of WRDA '86 provides for a 50%/50% cost sharing of the separable cost of this feature.

c. Beach Erosion Control. Prior to enactment of WRDA '86, shore protection projects were traditionally developed for the purpose of shore (beach) erosion control, and/or hurricane protection. Beach erosion control projects provided for restoration of publicly-owned shores available for use by the general public. Private properties could be included if such protecting and restoration was incidental to the protection of publicly-owned shore or if such protection would result in public use benefits. Public use was defined as use by all on equal terms. Public use was not a condition for Federal participation in hurricane protection, as this purpose was considered analogous to flood control. When both purposes were served by a project, costs were allocated between purposes. The WRDA '86 discontinued shore (beach) erosion control as a project purpose.

d. Navigation. Incidental to the Corps mission of maintaining the nation's rivers and harbors. in certain instances, material dredged from such activities can be used for beach fill purposes. Authority for such operations was contained in Public Law 94-587 (Water Resources Development Act of 1976), as amended by Section 933 of WRDA '86. Currently, this authority and related regulations allow Federal participation in 50% of the added costs (in relation to the least cost navigation disposal alternative) of dredged material placement for beach nourishment purposes, providing the placement is economically justified, and other conditions common to Civil Works storm damage reduction projects are met. Where all of these conditions cannot be met, placement can still be accomplished if non-Federal interests provide all of the added costs, and the placement is environmentally acceptable and in the public interest.

e. Mitigation. If an existing Federal navigation project is identified to a quantifiable degree as a contributing factor in erosion and attendant damage along an adjacent shore, structural or non-structural (beach fill) measures may be used as corrective measures under the authority of Section 111 of the River and Harbor Act of 1968 (Public Law 90-483), as amended, if these measures are demonstrated to be economically justified. This authority is one of the U.S. Army Corps of Engineers "Continuing Authorities" programs which does not require specific project authorization by Congress unless the total costs of corrective measures under Section 111 exceed $2 million. Congressional authorization would be required if the $2 million limit is exceeded on any Section 111 project.

f. Report Summary. A list of completed projects by project purpose is presented in Table 2A. Authorized projects for which construction has not been completed as well as projects in PED and authorized studies are listed in Table 2B. As shown in Table 2A, the majority, 70 of the 82 projects (85%), contain beach erosion control as a project purpose, either as a singular purpose or as part of a multipurpose project. The next most prevalent purposes are hurricane and storm damage reduction and recreation, both of which are included either by themselves or as a part of a multiple purpose project in 53 (65%) of the projects. Navigation is considered in only four projects and mitigation in only two projects. The predominance of beach erosion control and recreation projects in the totals is attributable to older projects which were authorized and constructed before WRDA '86. As shown in Table 2B, hurricane and storm damage reduction is a project purpose in 38 of the 41 unconstructed projects/studies (93%), while beach erosion control is in 23 projects (56%) and recreation in 22 projects (54%).

Table 2A
Project Purpose - Completed Projects

Shore Protection Project Purpose	Number of Projects	Protected Shoreline Distance (miles)
Hurricane and Storm Damage Reduction (HSDR)	4	10.45
HSDR/Recreation (REC)	4	13.56
HSDR/REC/Beach Erosion Control (BEC)	30	103.83
HSDR/REC/BEC/Navigation	1	2.65
HSDR/REC/BEC/Mitigation	1	1.30
HSDR/BEC	10	33.65
HSDR/Navigation	2	5.28
Recreation	2	0.53
Recreation/BEC	15	16.94
Beach Erosion Control	11	21.69
BEC/Navigation	1	0.95
BEC/Mitigation	1	15.00
Total	82	225.83

Table 2B
Project Purpose - Authorized Projects and Studies

Shore Protection Project Purpose	Number of Projects/ Studies	Protected Shoreline Distance (miles)
Hurricane and Storm Damage Reduction (HSDR)	12	106.10
HSDR/Recreation (REC)	4	36.69
HSDR/REC/Beach Erosion Control (BEC)	12	63.66
HSDR/REC/BEC/Navigation	1	4.60
HSDR/REC/BEC/Mitigation	4	11.96
HSDR/BEC	5	98.73
Recreation	1	1.10
Beach Erosion Control	1	6.16
Navigation	1	7.95
Total	41	336.95

4. PROJECT FEATURES

a. General. The features of shore protection projects usually consist of one or a combination of the following functional elements: beach fills and dune fills (soft or non-structural measures); and groins, seawalls, revetments, breakwaters, bulkheads and sand transfer plants (hard or structural measures). There is no specific or singular functional feature that can be applied universally to solve all shore protection problems. Most project sites have some unique characteristics and must be evaluated on the basis of their particular attributes in order to develop a project plan that affords the best balance between functional performance, cost-efficiency, return of economic benefits, and environmental acceptability. The protection of relatively long reaches of shoreline, more often than not, involves the placement of beach fill and the provision of subsequent periodic nourishment. However, even in these cases, many project sites require detailed assessments to determine, for example, whether or not groins are needed for all or part of the fill or how much fill to place, how long the fill will last before needing to be renourished, and whether a dune fill or seawall should be used to account for storm tide effects.

b. Report Summary. A list of constructed projects, by project feature, is presented in Table 3A. Project features for authorized projects for which construction is not complete and for projects in PED and authorized studies are listed in Table 3B. In reference to 82 projects, 20 (24%) involve non-structural beach restoration or nourishment fills, 10 (12%) rely solely on structural measures, and the remaining 52 (64%) involve a combination of structural and non-structural measures. As shown in

Table 3B, the authorized projects and studies have a higher percentage of non-structural projects. Of these newer 41 projects and studies, 22 (54%) are non-structural, three (7%) are structural and 16 (39%) are a combination of structural and non-structural.

Table 3A
Project Feature-Completed Projects

Shore Protection Project Feature	Number of Projects	Protected Shoreline Distance (miles)
Initial Beach Restoration (IBR)	4	13.15
IBR/Nourishment (N)	15	48.34
IBR/N/Groin Field (GF)	11	15.00
IBR/N/GF/Breakwater	1	3.60
IBR/N/GF/Breakwater/Revetments	1	0.99
IBR/N/GF/Revetments	2	1.73
IBR/N/Sand Bypassing	1	0.66
IBR/N/Terminal Groin	15	47.61
IBR/N/Terminal Groin/Breakwater	1	0.28
IBR/N/Terminal Groin/Revetments	2	4.10
IBR/N/Breakwater	2	2.01
IBR/N/Revetments	2	9.40
IBR/N/Tidal Surge Protection	2	25.15
IBR/N/Other	3	14.05
IBR/GF	4	12.88
IBR/GF/Revetments	1	1.61
IBR/Terminal Groin	3	1.42
Nourishment	1	6.16
N/Terminal Groin	1	0.28
Groin Field	1	1.86
GF/Breakwater	1	0.95
GF/Revetments	1	0.38
Sand Bypassing	1	0
Terminal Groin	1	0.36
Revetments	5	13.86
TOTALS	82	225.83

Table 3B

Project Feature - Authorized Projects and Studies

Shore Protection Project Feature	Number of Projects/Studies	Protected Shoreline Distance (miles)
Initial Beach Restoration (IBR)/Periodic Nourishment (N)	21	167.21
IBR/N/Groin Field	4	57.33
IBR/N/Groin Field/Terminal Groin	1	7.00
IBR/N/Groin Field/Terminal Groin/Breakwater	2	50.00
IBR/N/Terminal Groin	6	38.67
IBR/N/Terminal Groin/Revetments	1	2.70
IBR/N/Revetments	1	0.30
Periodic Nourishment	1	(1)
Periodic Nourishment/Revetments	1	0.21
Revetments	3	13.53
Total	41	336.95

Footnote: (1) Section 934 study to nourish a portion of the Virginia Beach, VA, project listed under "Constructed Projects."

5. PROGRAM STATUS

In reference to Tables 2 and 3, there are 82 completed projects and another 41 authorized projects, projects in PED and studies. These two categories are further subdivided into seven categories in Table 4 to give a more detailed picture of the current Federal shore protection program. In addition, Table 4 indicates that over time, 14 shore protection projects have either been placed in the inactive category or have been deauthorized.

Table 4
Program Status

Shore Protection Project Status	Number of Projects/Studies	Protected Shoreline Distance (miles)
Large Constructed Projects	56	209.86
Small Specifically Authorized Constructed Projects	26	15.97
Subtotal Constructed	82	225.83
Under Construction	1	0.21
Authorized/Awaiting Initiation of Construction	10	39.89
Preconstruction Engineering Design	15	110.60
Subtotal Authorized/PED but Unconstructed Projects	26	150.70
Feasibility Phase (GI Study)	5	51.20
Reconnaissance Phase (GI Study)	10	135.05
Subtotal Studies	15	186.25
Total Projects and Studies	123	562.78
Inactive Studies	3	
Deauthorized Projects	11	
Total Authorized and Deauthorized	137	

6. CONTINUING AUTHORITIES PROGRAM

a. Authorization. There are six legislative authorities under which the Secretary of the Army, acting through the Chief of Engineers, is authorized to plan, design, and construct certain types of water resources improvements without specific Congressional authorization. These authorities are called the Continuing Authorities Program when referred to as a group. Three of these authorities pertain partly or entirely to shoreline protection and beach erosion control projects; specifically:

(1). Section 14, Flood Control Act of 1946 (PL 79-526), as amended (Emergency streambank and shoreline erosion protection for public facilities and services). This program applies only partly to the shoreline and beach erosion control projects. The Federal funding limit per project is currently $500,000 with a program limit of $12,500,000 per year.

(2). Section 103, River and Harbor Act of 1962 (PL 87-874), as amended, originally Section 3, an Act authorizing Federal participation in the cost of protecting the shores of publicly owned property, approved August 13, 1946 (Beach erosion control). The Federal funding limit per project is currently $2,000,000 with a program limit of $30,000,000 per year.

(3). Section 111, River and Harbor Act of 1968 (PL 90-483), as amended (Mitigation of shoreline erosion damage caused by Federal navigation projects). The Federal funding limit per project is currently $2,000,000 with no yearly program limit.

b. Extent of Program. Since 1987, the U.S. Army Corps of Engineers has constructed only 14 projects that relate to shoreline and beach erosion control under the Section 103 Continuing Authorities program. The projects and the total cost of these projects are provided in Table 5. This total program cost since 1987 has been only $19.5 million or less than $3 million per year and is less than 2% of the total shore protection program. The Federal expenditure has been much less. Since historical data is limited and the total program is minor with respect to the specifically authorized program, these projects are not included in the report totals.

Table 5
Continuing Authorities Program - Section 103
Projects Completed or Under Construction Since 1 January 1987

Division/ District	Authority[1]	Project	Total Project Cost ($ thousands)
NED	103	Prospect Beach, West Haven CT	2,268
	103	Sea Bluff Beach, West Haven, CT	450
	103	Woodmont Beach, Milford, CT	1,184
NAP	103	N. Shore Indian River Inlet., DE	886
	103	S. Shore Indian River Inlet.,DE	1,029
NAB	103	North Beach, Calvert Co., MD	835
	103	Colonial Beach, VA	1,711
NCB	103	Century Park, Lorain, OH	604
	103	Sims Park, Euclid, OH	1,345
NCC	103	Lake Bluff-Sunrise Park, IL	300
NPS	103	Lincoln Park Beach, Seattle, WA	3,423
SPN	103	Emeryville Point Park, CA	1,088
POD	103	*Lepua Area*, AS	1,959
	103	Sand Island, Oahu, HI	2,452
Total		14 Projects	19,532

Footnote: 1 Section 103 of the 1962 River and Harbor Act (Beach Erosion Control).

7. SPECIFICALLY AUTHORIZED PROJECTS OF SMALL TYPE

a. Overview. Prior to enactment of Section 103 of the 1962 River and Harbor Act and Section 111 of the 1968 River and Harbor Act, several shore protection projects were authorized which were small in size and cost. If a "Continuing Authority Program" had been in effect at that time, these projects would have been constructed under those authorities. All of these types of projects were identified by either the New England Division (21 projects) or the Los Angles District (5 projects). The authorization, project length and cost data for these 26 projects are shown in Table 6. The total Federal cost, adjusted to 1993 price levels, for the New England Division projects is $5.6 million and for the Los Angles District projects it is $3.9 million. This total of $9.5 million is less than 0.1% of the total program and equates to an average of $365,000 per project for the 26 projects. The project purposes and features for these projects were included in the totals shown in above paragraphs 3 and 4. Shown on Tables 7 and 8, respectively, the small scope specifically authorized projects are grouped with the regularly authorized projects in order to identify the project purposes and features for each group.

Table 6

Small Scope Specifically Authorized Projects - Authorization and Cost Data

District	Project	Type Authorization (1)	Length of Shoreline (miles)	Year Authorized	Year Construction Completed	Original Cost of Construction ($000s)		Adjusted Cost of Construction to 1993 Price Levels ($000s)	
						Federal	Total	Federal	Total
NED	Compo Beach, CT	beach erosion	0.70	1950	1962	82	246	513	1540
NED	Silver Beach to Cedar Beach, CT	beach erosion	3.24	1954	1964	63	333	357	1900
NED	Cove Island, CT	beach erosion	0.23	1958	1961	49	145	294	882
NED	Calf Pasture Beach Park, CT	beach erosion	0.42	1958	1963	57	177	352	1102
NED	Cummings Park, CT	beach erosion	0.19	1958	1963	28	83	158	475
NED	Burial Hill Beach, CT	beach erosion	0.09	1950	1958	6	18	41	124
NED	Cuilford Point Beach, CT	beach erosion	0.08	1958	1961	15	45	86	256
NED	Gulf Beach, CT	beach erosion	0.23	1954	1958	21	64	145	433
NED	Hammonasset Beach, CT	beach erosion	1.89	1954	1956	171	513	1271	3814
NED	Sand Hill Cove Beach, CT	beach erosion	1.00	1954	1959	39	118	272	827
NED	Jennings Beach, CT	beach erosion	0.36	1950	1955	14	43	112	337
NED	Light House Point Park, CT	beach erosion	0.28	1958	1960	4	12	25	74
NED	Middle Beach, CT	beach erosion	0.13	1954	1958	9	28	63	188
NED	Sasco Hill Beach, CT	beach erosion	0.17	1950	1961	23	69	150	445
NED	Short Beach, CT (2)	beach erosion	0.47	1954	1955	0	0	0	0
NED	Southport Beach, CT	beach erosion	0.13	1950	1960	18	53	119	358
NED	Woodmont Shore, CT	beach erosion	0.76	1954	1959	54	166	347	1067
NED	North Scituate Beach, CT	beach erosion	0.47	1960	1969	107	214	473	948
NED	Town Beach, Plymouth, MA	beach erosion	0.25	1960	1963	6	17	31	94
NED	Wessagussett Beach, MA	beach erosion	0.49	1960	1969	181	381	733	1544
NED	Misquamicut Beach, RI	beach erosion	0.63	1958	1963	15	45	86	256
SPL	Imperial Beach, CA	beach erosion	0.95	1958	1961	69	157	434	997
SPL	San Diego Beach, Sunset Cliffs (3)	beach erosion	0.38	1966	1973	185	370	501	1003
SPL	Ocean Beach, CA (4)	mitigaiton	0.32	1958	1955	8	24	62	187
SPL	Dohemy Beach, CA	beach erosion	1.16	1960	1967	377	753	1915	3829
SPL	Anaheim Bay, CA	mitigation	0.95	1954	1959	148	486	957	3135

Footnote:

(1) a Type of Authorization: Beach Erosion. This signifies small beach erosion control projects authorized prior to the general authority provided by Section 103 of the River and Harbor Act of 1962. The updated Federal cost is less then $2,000,000 at 1993 price levels.

b Type of Authorization: Mitigation. This signifies small navigation mitigation projects authorized prior to the general authority provided by Section 111 of the River and Harbor Act of 1968. The updated Federal construction cost is less than $2,000,000 at 1993 price levels.

(2) No cost of construction charged to this project. Material put on the beach was from dredging a navigation channel.

(3) Authorized as part of a larger project with a cost in excess of $2,000,000. The more expensive part of the project was deauthorized, leaving a $370,000 revetment and dike project. Due to the scope of the completed project and the lack of information available, this project was designated as "Projects Which Are Continuing Authority Types".

(4) Authorized as part of a larger project with an estimated cost of $289,000. This particular $24,000 increment of the project was a reimbursement to the local interests for work they had previously accomplished as part of the authorized project.

Table 7

Project Purpose of Regular and Small Scope Specifically Authorized Projects

Shore Protection Project Purpose	Number of Projects[1]		Protected Shoreline Distance (miles)	
	Regular	SSSA	Regular	SSSA
Hurricane and Storm Damage Reduction (HSDR)	3	1	10.32	0.13
HSDR/Recreation (REC)	3	1	13.14	0.42
HSDR/REC/Beach Erosion Control (BEC)	21	9	95.44	8.39
HSDR/REC/BEC/Navigation	1	0	2.65	0
HSDR/REC/BEC/Mitigation	1	0	1.30	0
HSDR/BEC	10	0	33.65	0
HSDR/Navigation	1	1	4.28	1.00
Recreation	0	2	0	0.53
Recreation/BEC	8	7	15.20	1.74
Beach Erosion Control	6	5	17.93	3.76
BEC/Navigation	1	0	0.95	0
BEC/Mitigation	1	0	15.00	0
Total	5[illegible]	26	209.86	15.97

Footnote: 1 Regular: Congressionally authorized projects;
SSSA: Small scope specifically authorized beach erosion control and navigation mitigation projects authorized, respectively, before the Continuing Authority Programs of Section 103 of the 1962 River and Harbor Act and Section 111 of the 1968 River and Harbor Act.

Table 8 Project Features of Regular & Small Scope Specifically Authorized Projects

	Number of Projects (1)		Protected Shoreline Distance (miles)	
Shore Protection Project Feature	Regular	SSSA	Regular	SSSA
Initial Beach Restoration (IBR)	4	0	13.15	0
IBR/Nourishment (N)	9	6	43.21	5.13
IBR/N/Groin Field (GF)	7	4	12.63	2.37
IBR/N/GF/Breakwater	1	0	3.60	0
IBR/N/GF/Breakwater/Revetments	1	0	0.99	0
IBR/N/GF/Revetments	1	1	1.48	0.25
IBR/N/Sand Bypassing	1	0	0.66	0
IBR/N/Terminal Groin	8	7	43.76	3.85
IBR/N/Terminal Groin/Breakwater	1	0	0.28	0
IBR/N Terminal Groin/Revetments	2	0	4.10	0
IBR/N/Breakwater	2	0	2.01	0
IBR/N/Revetments	1	1	8.40	1.00
IBR/N/Tidal Surge Protection	2	0	25.15	0
IBR/N/Other	3	0	14.05	0
IBR/GF	4	0	12.88	0
IBR/GF/Revetments	1	0	1.61	0
IBR/Terminal Groin	1	2	0.15	1.27
Nourishment	1	0	6.16	0
N/Terminal Groin	0	1	0	0.28
Groin Field	1	0	1.86	0
GF/Breakwater	0	1	0	0.95
GF/Revetments	0	1	0	0.38
Sand Bypassing	1	0	0	0
Terminal Groin	0	1	0	0.36
Revetments	4	1	13.73	0.13
TOTAL	56	26	209.86	15.97

Table 8
(continued)

Project Features of Regular and Small Scope Specifically Authorized Projects

Footnotes:

1 Regular: Congressionally authorized projects;
SSSA: Small Scope Specifically Authorized beach erosion control and navigation projects authorized, respectively, before the Continuing Authorities Programs of Section 103 of the 1962 R&H Act and Section 111 of the 1968 R&H Act.

b. Elimination. As shown on Table 9, the 26 small specifically authorized projects are only 16 miles in length and comprise about 7% of the 226 miles of shoreline being protected. The $25.8 million dollar total construction cost (1993 dollars) does represent a sizable expenditure, yet the $9.5 million dollar Federal share is less than one percent of the cost of all constructed projects. In addition, there is limited historical data on these small projects built during the 50's and early to mid 60's. Accordingly, these 26 projects will not be discussed further in this report.

Table 9

Division Assessment of Regular and Small Scope Specifically Authorized Projects

Division	Total Shoreline[1] Distance (miles)	Significant Erosion[1] Distance (miles)	Number of Projects[2]		Protected Shoreline Distance (miles)	
			Regular	SSSA	Regular	SSSA
NED	8,620 (3)	7,460 (3)	9	21	13.7	12.2
NAD			11	0	51.5	0
SAD	14,620	2,820	22	0	107.0	0
LMVD	1,940	1,580	1	0	7.0	0
SWD	2,550	360	2	0	4.5	0
NCD	3.680	1,260	0	0	14.8	0
NPD	50,140	5,360	0	0	0	
SPD	1,810	1,550	5	5	11.3	3.8
POD	930	110	0	0	0	0
TOTAL	84,240	20,500	56	26	209.8	16.0

Footnotes:
1 From the 1971 National Shoreline Study
2 Regular: Congressionally authorized projects;
SSSA: Small Scope Specifically Authorized beach erosion control and navigation projects authorized, respectively, before the Continuing Authorities Programs of Section 103 of the 1962 R&H Act and Section 111 of the 1968 R&H Act.

3 Total for NED and NAD

8. OPERATION AND MAINTENANCE

a. General. Under the provisions of WRDA '86, the non-Federal sponsor must operate, maintain, repair, replace and rehabilitate (O&M), a completed shore protection project. A unique aspect of beach fill projects is the provision for continuing Federal participation in the periodic nourishment of such projects where sand is placed on the beach, berm, or dune to replenish eroded material. Periodic nourishment is considered to be a continuing construction feature for funding and cost sharing purposes. It is undertaken when necessary to replace storm induced sand losses and to prevent excessive interim erosion of the authorized beach design profile.

b. Operation. Operation activities of a beach fill project would include assuring public access and safety, providing basic amenities, protection of dunes, prevention of encroachments, and monitoring of beach design section conditions. Operation of the project should also assure that no acts of man erode or damage the integrity of the beach fill, berm and/or dune, or any structure that may be a part of the project.

c. Maintenance. Maintenance of a shore protection project includes not only maintaining, but also periodic replacement, repair, or rehabilitation of the measures/structures comprising the project. For a beach fill project, the primary maintenance responsibility would be to maintain the beach, berm, and dune design section by sand relocation (moving sand laterally along the beach) and profile reshaping (moving sand perpendicular to the shore), but excluding beach nourishment that is incorporated in the project as deferred construction. Maintenance would also include the maintenance, replacement and repair of dune walk overs, dune vegetation or sand fencing and to make all necessary repairs to assure the integrity and working order of any fixed structure.

d. Report Summary. The study questionnaire contained three questions with respect to operation and maintenance: is there an O&M manual; if no, is there periodic monitoring and/or inspection; and, what is the frequency of monitoring and/or inspection? The results of the questionnaire are shown in Table 10. In summary, of the 56 major projects that have been constructed, 15 have an O&M manual. Of the 39 projects that do not have and O&M manual, 21 are monitored and/or inspected periodically. For those that are inspected, the frequency of periodic inspection varies from once every month to as needed. Of the 36 projects that either have an O&M manual and/or are inspected, 21 are inspected annually.

Table 10

Operation and Maintenance Summary

Number of Projects	Type of Project	O&M Manual #Yes	O&M Manual #No	If No, Periodic Monitoring #Yes	If No, Periodic Monitoring #no	Range of Frequency of[1] Monitoring (Years to Years)
2	Initial Beach Restoration (IBR)	2	0	0	0	Annually
16	IBR/Nourishment (IBR/N)	3	13	8	5	Quarterly/As Needed
5	IBR/Hard Structures	0	5	3	2	Quarterly/Every 2 Years
21	IBR/N/Hard Structures	5	15	7	8	Monthly/Annually
5	N/Hard Structures	2	3	2	1	Quarterly/Every 2 Years
7	Hard Structures	3	3	1	2	Quarterly/Annually
56	TOTALS	15	39	21	18	Monthly/As Needed

Footnote: 1 Number and Frequency of Monitoring as follows:

1	Monthly
7	Quarterly
1	6 Months to 1 Year
21	Annually
3	Every 2 Years
1	Every 4 Years
2	As Needed

CHAPTER III - COST OF SHORE PROTECTION PROJECTS

1. INTRODUCTION

This chapter presents a compilation and evaluation of the extensive cost and other data obtained through the study questionnaires. Detailed data on these authorized Federal projects were summarized and compared in order to gain a national perspective of the overall shore protection program. The primary focus is a comparison of costs, the quantities of sand used in beach restoration and nourishment. The final report will further examine costs but will have a primary focus on benefits, environmental impacts, and induced development effects associated with the Federal shore protection program.

As previously noted, the portfolio of constructed Federally sponsored shore protection projects contains 82 specifically authorized projects of various types which span a combined shoreline distance of approximately 226 statute miles. Of the total 82 projects, 26 were very small in scope and covered only 16 of the 226 miles of protected shoreline distance. These 26 small projects, which cost a total of $4.56 million at time of construction, were not considered in the detailed analysis which follows in this chapter. Therefore, the cost analysis presented below includes only the 56 large, constructed projects. Future estimates are also provided for 26 projects which are either authorized but unconstructed or are not authorized but are at the Preconstruction Engineering and Design (PED) stage.

This chapter centers on discussions associated with the answers to the following questions: 1) "How much money has been spent to date on Federal shore protection projects?"; 2) "How much sand has been placed to date on Federally supported shore protection projects?"; 3) "How do actual expenditures and quantities of sand compare with the original estimates for the projects?"; and 4) "What future financial commitments are associated with the beach nourishment projects already constructed, and those in the planning stages?"

2. ACTUAL HISTORICAL COSTS OF THE SHORE PROTECTION PROGRAM (not adjusted)

a. Overview of Entire Program. Actual expenditures on the 56 large authorized shore protection projects are summarized below in Table 11. These figures are cumulative over the period from 1950 to 1993, and are not adjusted to current dollar levels. Total expenditures were $670.2 million, and the Federal share of this amount was $403.2 million, or 60%. The major proportion (80.4%) of these expenditures were for beach restoration and periodic nourishment measures, with initial beach restoration accounting for $307.8 million and periodic nourishment accounting for $230.9 million. Structural measures cost $115.6 million, and $15.9 million was spent on emergency measures.

Table 11
Total Actual Expenditures Shore Protection Program 1950-1993
($ million)

Type of Measure	Federal Costs	Total Costs
Initial Restoration	184.9	307.8
Periodic Nourishment	143.0	230.9
Structures	59.4	115.6
Emergency Measures	15.9	15.9
Total	403.2	670.2

b. Historical Pattern. The history of both Federal and total expenditures on the 56 Federally supported shore protection projects from 1950 to 1993 is contained in Table 12. Note that these are actual yearly expenditures which have not been adjusted to 1993 dollar levels. The spending by project element was: 46% for initial beach restoration; 35% for periodic nourishment; 17% for structures; and 2 % for emergency measures.

c. Individual Projects. Actual expenditures are displayed by individual project and project elements in Table 13. The largest project in terms of dollars expended was Dade County, FL, where a total of $82.9 million dollars was spent. Other major projects were: Presque Isle, PA - $50.1 million; the Atlantic Coast of New York City at Rockaway - $47.1 million; and Channel Islands Harbor, CA - $40.3 million.

Table 12 - Actual Expenditures by Year 1950-1993 ($000s)

(continued on the next page)

Year	Initial Beach Restoration		Periodic Nourishment	
	Federal Costs	Total Costs	Federal Costs	Total Costs
1950	435	1305	0	0
1951	0	0	0	0
1952	856	856	0	0
1953	0	0	0	0
1954	0	0	0	0
1955	119	355	0	0
1956	552	1657	0	0
1957	86	283	0	0
1958	150	480	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	2642	2642	350	500
1962	43	129	0	0
1963	384	1153	836	836
1964	1102	1624	84	168
1965	1559	2413	1424	1660
1966	404	1160	313	506
1967	187	255	233	402
1968	1267	2347	2405	2529
1969	715	1197	51	80
1970	3609	5659	251	416
1971	927	1526	1964	2946
1972	0	0	335	683
1973	207	2428	2462	2850
1974	1209	1578	1173	1675
1975	10628	16462	3240	3865
1976	9900	13823	1245	2088
1977	1653	2770	908	1381
1978	8826	15845	1199	3597
1979	5060	8515	4562	4364
1980	9405	19903	2878	5578
1981	7427	14295	4919	6447
1982	11907	23173	9139	18299
1983	783	1119	8027	14369
1984	0	0	5855	15471
1985	11064	15011	9818	10949
1986	0	0	7571	14198
1987	0	0	10540	16643
1988	3558	6937	15456	22897
1989	19219	37153	8961	11328
1990	9696	14489	7888	13338
1991	16613	26507	15241	28629
1992	18757	32189	9232	17013
1993	23954	30585	4444	5180
Totals	**184901**	**307822**	**143002**	**230885**

Table 12 - Actual Expenditures by Year 1950-1993 ($000s)
(continued)

Year	Structures		Emergency Costs	Total Yearly Costs	
	Federal Costs	Total Costs		Federal	Total
1950	186	559	0	621	1864
1951	0	0	0	0	0
1952	277	736	0	1133	1592
1953	0	0	0	0	0
1954	0	0	0	0	0
1955	6	19	0	125	374
1956	212	635	0	764	2292
1957	19	62	0	105	345
1958	111	577	0	261	1057
1959	817	817	0	817	817
1960	2619	2619	0	2619	2619
1961	65	331	0	3057	3473
1962	261	588	560	864	1277
1963	6465	9335	0	7685	11324
1964	46	1	0	1232	1793
1965	2117	3196	0	5100	7269
1966	191	629	0	908	2295
1967	335	278	0	755	935
1968	681	8878	0	4353	13754
1969	993	9343	405	2164	11025
1970	2792	4187	406	7058	10668
1971	34	49	5	2930	4526
1972	1	1	19	355	703
1973	460	677	194	3323	6149
1974	1608	2298	235	4225	5786
1975	1355	2619	0	15222	22946
1976	190	379	10	11345	16300
1977	588	840	0	3149	4991
1978	247	363	1750	12022	21555
1979	0	0	0	9622	12879
1980	0	0	1472	13754	26953
1981	0	0	0	12346	20742
1982	0	1682	0	21046	43154
1983	11009	16747	0	19819	32235
1984	211	422	88	6154	15981
1985	327	654	289	21498	26903
1986	2606	4090	3103	13280	21391
1987	273	546	0	10813	17189
1988	280	284	0	19294	30118
1989	120	1178	0	28300	49659
1990	2175	2588	370	20129	30785
1991	3977	8064	2223	38053	65423
1992	14402	26609	2335	44726	78146
1993	1368	2743	2465	32231	40973
Totals	**59422**	**115623**	**15929**	**403255**	**670259**

Table 13 - Actual Expenditures by Project

(continued on next page)

Project	District	Initial Beach Restoration	Periodic Nourishment	Structures	Emergency Costs	Total Project Costs
1. Prospect Beach, CT	CENED	283	(1)	62	0	345
2. Seaside Park, CT		480	(1)	0	0	480
3. Sherwood Island State Park, CT		1119	(1)	107	0	1226
4. Quincy Shore Beach, MA		1305	(1)	559	0	1864
5. Revere Beach, MA		3015	0	0	0	3015
6. Winthrop Beach, MA		344	(1)	186	0	530
7. Hampton Beach, NH		515	(1)	130	0	645
8. Wallis Sands State Beach, NH		441	0	60	0	501
9. Cliff Walk, RI		0	0	1361	0	1361
DIVISION TOTALS - CENED		**7502**	**0**	**2465**	**0**	**9967**
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay	CENAN	12825	30829	1682	1750	47086 0
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet		13150	22557	0	0	35707 0
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach		3900	0	4400	0	8300 0
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton		0	0	560	0	560 0
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		1156	0	158	0	1314 0
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		0	0	19081	0	19081 0
16. DE Coast Sand Bypass - Indian River	CENAP	0	813	1876	88	2777
17. Cape May Inlet to Lower Township, NJ		13002	0	3368	0	16370
18. Great Egg Harbor Inlet and Peck Bch, NJ		27184	0	2253	0	29437
19. Atlantic Coast of MD-Ocean City, MD	CENAB	23290	685	5919	2335	32229
20. Virginia Beach , VA	CENAO	0	12800	0	560	13360
DIVISION TOTALS - CENAD		**94507**	**67684**	**39297**	**4733**	**206221**
21. Wrightsville Beach, NC	CESAW	577	5470	0	760	6807
22. Carolina Beach and Vicinity, NC		983	16881	42	1769	19675
23. Fort Macon, NC		46	0	906	0	952
24. Folly Beach	CESAC	7184	0	1609	0	8793
25. Tybee Island BEC	CESAS	2628	1989	1483	289	6389

Table 13 - Actual Expenditures by Project

(continued)

Project	District	Initial Beach Restoration	Periodic Nourishment	Structures	Emergency Costs	Total Project Costs
26. Pinellas Co.-Sand Key Segment	CESAJ	30430	0	1200	0	31630
27. Broward Co.-Segment 2		1759	9988	0	0	11747
28. Broward Co. and Hillsboro Inlet-Segment 3		10982	15892	0	0	26874
29. Brevard Co.-Indialantic/Melbourne		3552	0	0	0	3552
30. Brevard Co.-Cape Canveral		1026	0	0	0	1026
31. Fort Pierce Beach, FL		621	1428	0	0	2049
32. Duval Co., FL		9579	15763	0	0	25342
33. Pinellas Co.-Long Key Segment		803	1752	935	0	3490
34. Pinellas Co.-Treasure Is. Segment		595	1776	851	3217	6439
35. Virginia Key and Key Biscayne		602	438	1367	0	2407
36. Dade Co.-BEC and Hurricane Protection		67281	10711	4867	0	82859
37. Lee Co.-Captiva Island Segment		6418	0	0	0	6418
38. Palm Beach Co.-Boca Raton Section		3547	0	0	0	3547
39. Palm Beach Co.-Delray Beach Segment		2119	10525	0	0	12644
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet		0	0	577	0	577
41. Manatee Co., FL		8450	0	0	0	8450
42. Harrison Co., Mississippi	CESAM	856	0	736	0	1592
DIVISION TOTALS - CESAD		**160038**	**92613**	**14573**	**6035**	**273259**
43. Grand Isle and Vicinity, LA	CELMN	10534	7571	284	4688	23077
44. Corpus Christi Beach, TX	CESWG	2078	1408	301	0	3787
45. Galveston Seawall		0	0	9335	0	9335
46. Presque Isle	CENCB	5692	24637	19723	0	50052
47. Lakeview Park Cooperative BEC, OH		834	159	840	0	1833
48. Hamlin Beach State Park, OH		1178	0	1200	0	2378
49. Point Place, OH		0	0	14122	0	14122
50. Reno Beach, OH		0	0	6554	0	6554
51. Maumee Bay		1517	0	785	0	2302
52. Surfside/Sunset	CESPL	17712	0	1266	0	18978
53. Oceanside		1153	2608	195	0	3956
54. Channel Islands Harbor		2642	34205	3436	0	40283
55. Coast of CA, Point Mugu to San Pedro		1800	0	648	0	2448
56. Ventura-Pierpont Area		635	0	599	473	1707
DIVISION TOTALS - Other Coastal		**45775**	**70588**	**59288**	**5161**	**180812**
TOTAL PROGRAM		**307822**	**230885**	**115623**	**15929**	**670259**

(1). Periodic nourishment costs for these projects were not available. Periodic nourishment was the responsibility of the local sponsors and the NED office does not have any records indicating whether or not it was done.

3. ADJUSTING COSTS TO 1993 DOLLAR LEVEL

a. General. How best to adjust past costs to 1993 price levels, was one of the first issues identified during the data gathering process. The study data bank contains cost estimates for each project as recorded in Feasibility Reports, General Design Memoranda and similar documents which have price levels ranging from 1947 to 1993. Each project also has a historical record of actual expenditures, by year, ranging from 1950 to 1993. The price levels of these actual expenditures are related to the specific years in which the expenditures occurred. In order to make a meaningful comparison of actual and estimated costs, a method was needed to convert the various price levels to a 1993 price base.

b. Beach and Restoration Nourishment.

The Shoreline Protection and Beach Erosion Control Task Force decided that a traditional (price/cost index) type of adjustment would not properly represent what it would cost in 1993 dollars to construct the previously completed beach nourishment projects. The concern was that historical dredging costs have not followed a gradual, steady, upward pattern characteristic of the Engineering News Record (ENR) Construction Cost Index. Further, the ENR Index is developed without consideration or use of the cost data related to the dredging industry. Therefore, dredging costs adjusted by the ENR index may be higher or lower based on whether the actual dredging costs were abnormally high or low in the year of construction.

As a matter of interest, application of the ENR Index to adjust the overall dredging costs related to the projects examined in this study, would result in costs which would amount to only 79 percent of the costs adjusted by means of directly applying current dredging costs on a project-specific basis. This suggests that, in general, the ENR Index underestimates the current (1993) costs of dredging for beach fills by approximately 20 percent.

Dredging costs, per se, have varied significantly from year to year due to a number of variables including the erratic fuel costs resulting from the Oil Embargo, and the demand for dredging at certain busy or slack periods for the industry. Accordingly, it was decided to adjust dredging costs on a project-specific basis in accordance with prevailing 1993 dredging cost at the general project site. Apart from the basic costs associated with operating a particular dredging plant, costs for placing sand in the restoration or periodic nourishment of beaches vary regionally and through time in response to numerous project related factors such as: location and wave exposure of the sand source area; accessibility; quantities; material quality; environmental constraints; special handling requirements and pumping distances. Costs of sand for a particular project may be greater or less from year to year and may deviate significantly from the values given in original authorizing documents. In addition, sand costs in some areas of the country and

for some specific projects are significantly higher than for others.

The unit cost of sand placement may not only vary within a single project between estimated and actual, but also, between initial beach restoration and subsequent periodic nourishment. For example, if less sand is placed than originally estimated, the unit cost of sand may be higher because the equipment mobilization and demobilization costs are fixed and distributed over a smaller volume of material. If the sand supply for the beach nourishment project is excavated as part of a navigation project or mined from a source close to the beach, the cost of the sand per cubic yard may drop. If the source of material is changed due to environmental constraints, available quantities, accessibility, or market competition, the cost may increase or decrease relative to that estimated. Generally, those projects which require only a small amount of sand from a distant source and those with stringent environmental or material quality requirements will be relatively expensive. On the other hand, those projects which include large quantities of material from nearshore or navigation project dredging tend to have relatively low unit costs. Sand for periodic nourishment may be more expensive than the initial beach restoration fill because smaller quantities of material are involved. Numerous other possibilities could be enumerated to explain how overall dredging sand placement costs could vary from low to high. The important point here is, that a single index value to adjust dredging placement costs to 1993 dollar amounts is not feasible; hence cost adjustments were performed on a project-specific basis.

c. Structures. For structural components of shore protection projects, costs were adjusted by applying the Engineering News Record Construction Cost Index.

4. INITIAL BEACH RESTORATION

a. Volumes of Sand.

(1). Overview of Program. According to the projects survey conducted for this study, 49 of the 56 projects involved initial beach restoration. These 49 projects are indicated by an asterisk in the third column on Table 14. The total volume of sand placed was 110.6 million cubic yards, distributed among the regions of the country as follows: 22% in the North Atlantic Division; 46% in the South Atlantic Division; and 32% in the other coastal divisions. The total volume estimated to be placed for initial beach restoration was 126.5 million cubic yards. However, this value includes several projects where initial beach restoration was planned, but not implemented, and where there was missing information.

(2). Program Comparison. In order to present a comparison of actual and estimated volumes of sand placed, those projects which had missing data or which were not constructed as planned had to be deleted. Most of the projects for which information was not available were build in the 1950's and 1960's. This reduced the list to 39 projects which could be compared. These 39 projects are denoted by an asterisk in the last column of Table 14. The actual volume placed for these 39 projects was 94.5 million cubic yards compared to an estimate of 93.7 million cubic yards; resulting in an actual/estimate ratio of 1.01. A summary of program overview and comparison is presented below.

Program Summary of Initial Beach Restoration, Volumes of Sand

Number of Projects	Actual (million c.y.)	Estimated (million c.y.)	Actual/Estimated Ratio
39	94.5	93.7	1.01

(3). Project Comparison. To facilitate a quick comparison of actual and estimated volumes of sand for each project, actual/estimated ratios of sand quantities are given in the sixth column of Table 14. For the 39 projects for which a valid comparison could be made, 22 have ratios greater than one, indicating that actual cubic yards of sand were greater than estimated, 13 have ratios less than one, indicating that actual volumes of sand were less than estimated, and four ratios were exactly one, indicating that actual and estimated volumes of were equal. In 30 percent of the projects (12 of 39), the actual quantities of sand were within 10 percent of the estimated quantities.

Table 14 - Initial Beach Restoration, Volumes of Sand by Project

(continued on next page)

Project	District	Projects with Initial Beach Restoration	Cubic Yards (000s)		Cubic Yards Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
1. Prospect Beach, CT	CENED	•	(1)	380		
2. Seaside Park, CT		•	(1)	635		
3. Sherwood Island State Park, CT		•	113	420	0.27	•
4. Quincy Shore Beach, MA		•	(1)	357		
5. Revere Beach, MA		•	670	768	0.87	•
6. Winthrop Beach, MA		•	(1)	200		
7. Hampton Beach, NH		•	169	340	0.50	•
8. Wallis Sands State Beach, NH		•	(1)	200		
9. Cliff Walk, RI			0	0		
DIVISION TOTALS - CENED			952	3300		
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay	CENAN	•	6364	8195	0.78	•
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet		•	4123	8350	0.49	•
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach	(2)	•	1800	21450	NA	
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton			0	0		
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		•	(3)	838		
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		•	0	2725		
16. DE Coast Sand Bypass - Indian River	CENAP	•	0	80		
17. Cape May Inlet to Lower Township, NJ		•	1365	1450	0.94	•
18. Great Egg Harbor Inlet and Peck Bch, NJ		•	6070	4118	1.47	•
19. Atlantic Coast of MD-Ocean City, MD	CENAB	•	4941	3825	1.29	•
20. Virginia Beach , VA	CENAO		0	0		
DIVISION TOTALS - CENAD			24663	51031		
21. Wrightsville Beach, NC	CESAW	•	2993	2500	1.20	•
22. Carolina Beach and Vicinity, NC		•	3597	2016	1.78	•
23. Fort Macon, NC		•	93	135	0.69	•
24. Folly Beach	CESAC	•	3100	2500	1.24	•
25. Tybee Island BEC	CESAS	•	2267	1930	1.17	•

(1) Actual cu. yds. of initial beach restoration were not available because the projects were constructed by local sponsors and later reimbursed by the Corps.
(2) The estimates for Initial Beach Restoration for this project were for the entire reach, only a small portion of which was actually constructed.
(3) Actual cubic yards of Initial Beach Restoration was not available for this project.

Table 14 - Initial Beach Restoration, Volumes of Sand by Project

(continued)

Project	District	Projects with Initial Beach Restoration	Cubic Yards (000s)		Cubic Yards Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
26. Pinellas Co.-Sand Key Segment	CESAJ	*	2707	2670	1.01	*
27. Broward Co.-Segment 2		*	1030	1538	0.67	*
28. Broward Co. and Hillsboro Inlet-Segment 3		*	3070	3036	1.01	*
29. Brevard Co.-Indialantic/Melbourne		*	540	656	0.82	*
30. Brevard Co.-Cape Canveral		*	1250	890	1.40	*
31. Fort Pierce Beach, FL		*	718	950	0.76	*
32. Duval Co., FL		*	2486	3290	0.76	*
33. Pinellas Co.-Long Key Segment		*	253	243	1.04	*
34. Pinellas Co.-Treasure Is. Segment		*	600	517	1.16	*
35. Virginia Key and Key Biscayne		*	350	348	1.01	*
36. Dade Co.-BEC and Hurricane Protection		*	14601	15445	0.95	*
37. Lee Co.-Captiva Island Segment		*	1418	1039	1.36	*
38. Palm Beach Co.-Boca Raton Section		*	875	634	1.38	*
39. Palm Beach Co.-Delray Beach Segment		*	1340	1340	1.00	*
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet			0	0		
41. Manatee Co., FL		*	2200	2208	1.00	*
42. Harrison Co., Mississippi	CESAM	*	5700	5700	1.00	*
DIVISION TOTALS - CESAD			**51188**	**49585**		
43. Grand Isle and Vicinity, LA	CELMN	*	2870	2540	1.13	*
44. Corpus Christi Beach, TX	CESWG	*	742	720	1.03	*
45. Galveston Seawall			0	0		
46. Presque Isle	CENCB	*	4426	4400	1.01	*
47. Lakeview Park Cooperative BEC, OH		*	125	110	1.14	*
48. Hamlin Beach State Park, OH		*	317	244	1.30	*
49. Point Place, OH			0	0		
50. Reno Beach, OH			0	0		
51. Maumee Bay		*	143	163	0.88	*
52. Surfside/Sunset (4)	CESPL	*	14303	6005	NA	
53. Oceanside		*	2400	1300	1.85	*
54. Channel Islands Harbor		*	6225	5100	1.22	*
55. Coast of CA, Point Mugu to San Pedro		*	1405	1400	1.00	*
56. Ventura-Pierpont Area		*	883	643	1.37	*
DIVISION TOTALS - Other Coastal			**33839**	**22625**		

(4) Estimates for Initial Beach Restoration (cubic yards) are partial figures; no estimates were available for two stages of project construction.

b. Costs adjusted to 1993 Dollars.

(1). Overview of Program. As noted above, 49 of the 56 projects involved initial beach restoration. These 49 projects are identified by an asterisk in the third column on Table 15. The total actual cost of initial beach restoration adjusted to 1993 dollars, was $735 million. This total amount was distributed among the regions as follows: North Atlantic Division - 19%; South Atlantic Division - 55%; and other coastal divisions - 26%. The total estimated cost for initial beach restoration was $829.3 million in 1993 dollars. However, this latter number includes several projects where initial beach restoration was planned, but not implemented.

(2). Program Comparison. In order to present a comparison of costs, those projects which had missing data or which were not constructed as planned had to be deleted. This reduced the project list to 40 projects which could be compared in terms of initial beach restoration costs. These 40 projects are designated by an asterisk in the last column of Table 15. The actual costs of these projects was $657.0 million in 1993 dollars compared to estimated costs of $660.0 million in 1993 dollars, resulting in an actual/estimated cost ratio for initial beach restoration of 0.995. A summary of this program overview and comparison is presented below.

Program Summary of Initial Beach Restoration Costs

Number of Projects	Actual ($ million 1993)	Estimated ($ million 1993)	Actual/Estimated Ratio
40	657.0	660.0	0.995

(3). Project Comparison. Table 15 contains the adjusted 1993 dollar costs of initial beach restoration for each project, in terms of both actual costs and estimated costs. Cost ratios are also included in Table 15 for each project where they could be calculated (in this case, 40 projects). For nineteen projects, the actual/estimated cost ratio was greater than one, indicating that actual costs were higher than estimated costs; for seventeen projects, the ratios indicate that actual costs were lower than estimated costs; and for four projects, actual initial beach restoration costs were equal to the estimates. A little less than a quarter of the projects (9 of 40) had actual costs within 10% of the estimates.

Table 15 - Initial Beach Restoration, Adjusted Costs by Project

(continued on the next page)

Project	District	Projects with Initial Beach Restoration	Updated Costs ($ thousands 1993)		Actual/Estimated Cost Ratio	Project Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
1. Prospect Beach, CT	CENED	•	(1)	3420		
2. Seaside Park, CT		•	(1)	5715		
3. Sherwood Island State Park, CT		•	1017	3780	0.27	•
4. Quincy Shore Beach, MA		•	(1)	3213		
5. Revere Beach, MA		•	6030	6912	0.87	•
6. Winthrop Beach, MA		•	(1)	1800		
7. Hampton Beach, NH		•	1525	3060	0.50	•
8. Wallis Sands State Beach, NH		•	(1)	1800		
9. Cliff Walk, RI			0	0		
DIVISION TOTALS - CENED			**8572**	**29700**		
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay	CENAN	•	31565	40729	0.78	•
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet		•	24449	49516	0.49	•
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach	(2)	•	9000	107250	NA	
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton			0	0		
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		•	5944	5238	1.13	•
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		•	0	17031		
16. DE Coast Sand Bypass - Indian River	CENAP	•	0	133		
17. Cape May Inlet to Lower Township, NJ		•	14348	10397	1.38	•
18. Great Egg Harbor Inlet and Peck Bch, NJ		•	27316	18531	1.47	•
19. Atlantic Coast of MD-Ocean City, MD	CENAB	•	32117	24860	1.29	•
20. Virginia Beach , VA	CENAO		0	0		
DIVISION TOTALS - CENAD			**144739**	**273685**		
21. Wrightsville Beach, NC	CESAW	•	9245	7697	1.20	•
22. Carolina Beach and Vicinity, NC		•	8910	5535	1.61	•
23. Fort Macon, NC		•	279	405	0.69	•
24. Folly Beach	CESAC	•	7184	11311	0.64	•
25. Tybee Island BEC	CESAS	•	15597	13278	1.17	•

(1) For these projects, updates of actual costs were not available because the projects were constructed by local sponsors and later reimbursed by the Corps.

(2) The estimates for Initial Beach Restoration for this project were for the entire reach, only a small portion of which was actually constructed.

Table 15 - Initial Beach Restoration, Adjusted Costs by Project

(continued)

Project	District	Projects with Initial Beach Restoration	Updated Costs ($ thousands 1993)		Actual/Estimated Cost Ratio	Project Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
26. Pinellas Co.-Sand Key Segment	CESAJ	*	40563	37231	1.09	*
27. Broward Co.-Segment 2		*	18818	12838	1.47	*
28. Broward Co. and Hillsboro Inlet-Segment 3		*	49585	42504	1.17	*
29. Brevard Co.-Indialantic/Melbourne		*	6111	6888	0.89	*
30. Brevard Co.-Cape Canveral		*	4781	8010	0.60	*
31. Fort Pierce Beach, FL		*	4646	6022	0.77	*
32. Duval Co., FL		*	37583	49738	0.76	*
33. Pinellas Co.-Long Key Segment		*	1877	1811	1.04	*
34. Pinellas Co.-Treasure Is. Segment		*	6167	5450	1.13	*
35. Virginia Key and Key Biscayne		*	6016	5993	1.00	*
36. Dade Co.-BEC and Hurricane Protection		*	144969	139497	1.04	*
37. Lee Co.-Captiva Island Segment		*	11477	8665	1.32	*
38. Palm Beach Co.-Boca Raton Section		*	4471	5416	0.83	*
39. Palm Beach Co.-Delray Beach Segment		*	8630	8630	1.00	*
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet			0	0		
41. Manatee Co., FL		*	8534	15527	0.55	*
42. Harrison Co., Mississippi	CESAM	*	9975	9975	1.00	*
DIVISION TOTALS - CESAD			**405418**	**402421**		
43. Grand Isle and Vicinity, LA	CELMN	*	21170	18758	1.13	*
44. Corpus Christi Beach, TX	CESWG	*	4608	4588	1.00	*
45. Galveston Seawall			0	0		
46. Presque Isle	CENCB	*	38684	36530	1.06	*
47. Lakeview Park Cooperative BEC, OH		*	1061	937	1.13	*
48. Hamlin Beach State Park, OH		*	2887	3734	0.77	*
49. Point Place, OH			0	0		
50. Reno Beach, OH			0	0		
51. Maumee Bay		*	1608	1833	0.88	*
52. Surfside/Sunset (3)	CESPL	*	68971	28957	NA	
53. Oceanside		*	10892	5900	1.85	*
54. Channel Islands Harbor		*	18760	15370	1.22	*
55. Coast of CA, Point Mugu to San Pedro		*	4968	4950	1.00	*
56. Ventura-Pierpont Area		*	2659	1937	1.37	*
DIVISION TOTALS - Other Coastal			**176268**	**123494**		

(3) Cost estimates for Initial Beach Restoration are partial figures; no estimates were available for two stages of project construction.

5. PERIODIC NOURISHMENT

a. Volumes of Sand.

(1). Overview of Program. Based on the information collected in this study, 40 of the 56 projects involved periodic nourishment. These 40 projects are denoted by an asterisk in the third column of Table 16. The total volume placed was 79.1 million cubic yards, distributed among the regions as follows: 18% in North Atlantic Division; 36% in South Atlantic Division; and 46% in other coastal divisions. The total volume of sand estimated to be placed for periodic nourishment was 66.7 million cubic yards.

(2). Program Comparison. In order to present a comparison of actual and estimated cubic yards of sand used in periodic nourishment operations, those projects which had missing data had to be deleted. Periodic nourishment information (either for estimates, actual, or both) was not available for seven of the older projects. Most of these were built in the early 1950's. This reduced the project list for analysis to 33 projects which could be compared. These 33 projects are denoted by an asterisk in the last column of Table 16. The actual volume placed for these 33 projects amounted to 72.5 million cubic yards whereas the estimated volumes totaled to 64.7 million cubic yards. This yielded an actual/estimated ratio of 1.12. Thus, for the program as a whole, the amount of sand placed for periodic nourishment exceeded estimates by about 12 percent. A summary of the program overview and comparison is presented below.

Program Summary for Periodic Nourishment, Volumes of Sand

Number of Projects	Actual (million c.y.)	Estimated (million c.y.)	Actual/Estimated Ratio
33	72.5	64.7	1.12

(3). Project Comparison. A comparison of actual and estimated volumes of sand for each project is given by ratios of actual to estimated volumes in the sixth column of Table 16. For twelve of the 33 projects which had periodic nourishment data, ratios were either zero or undefined. Specifically, 10 projects had estimated requirements for nourishment whereas actual nourishment was not needed, resulting in a ratio of zero. On the other hand, there were 2 projects for which there were no estimated nourishment requirements which subsequently required placement of nourishment fills. This left 21 projects with non-zero, numerical ratios. There was more variability in these ratios than in the initial beach restoration ratios discussed above. In seven of these projects, the amount of sand placed for periodic nourishment exceeded the estimate, in thirteen projects the amount of sand placed for periodic nourishment was less than estimated, and in one project, actual periodic nourishment was equal to estimated periodic nourishment. In only three of the twenty-one projects were the

Table 16 - Periodic Nourishment, Volumes of Sand by Project

(continued on the next page)

Project	District	Projects With Periodic Nourishment	Volume of Sand (thousands cu.yd.)		Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
1. Prospect Beach, CT	CENED	•	(1)	344		
2. Seaside Park, CT		•	(1)	435		
3. Sherwood Island State Park, CT		•	(1)	110		
4. Quincy Shore Beach, MA			(1)	(1)		
5. Revere Beach, MA		•	0	80		•
6. Winthrop Beach, MA		•	(1)	205		
7. Hampton Beach, NH		•	(1)	931		
8. Wallis Sands State Beach, NH			0	0		
9. Cliff Walk, RI			0	0		
DIVISION TOTALS - CENED			0	2105		
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay	CENAN	•	5330	5360	0.99	•
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet		•	3308	(2)		
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach		•	0	225		•
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton			0	0		
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		•	0	22		•
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		•	0	28		•
16. DE Coast Sand Bypass - Indian River	CENAP	•	240	700	0.34	•
17. Cape May Inlet to Lower Township, NJ		•	710	720	0.99	•
18. Great Egg Harbor Inlet and Peck Bch, NJ		•	0	1072		•
19. Atlantic Coast of MD-Ocean City, MD	CENAB	•	184	0		•
20. Virginia Beach , VA	CENAO	•	4472	1875	2.39	•
DIVISION TOTALS - CENAD			14244	10002		
21. Wrightsville Beach, NC	CESAW	•	5506	1416	3.89	•
22. Carolina Beach and Vicinity, NC		•	7510	5087	1.48	•
23. Fort Macon, NC		•	0	150		•
24. Folly Beach	CESAC		0	0		
25. Tybee Island BEC	CESAS	•	1300	1580	0.82	•

Table 16 - Periodic Nourishment, Volumes of Sand by Project

(continued)

Project	District	Projects With Periodic Nourishment	Volumes of Sand (thousands cu.yd.)		Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
26. Pinellas Co.-Sand Key Segment	CESAJ	*	0	280		*
27. Broward Co.-Segment 2		*	1750	2954	0.59	*
28. Broward Co. and Hillsboro Inlet-Segment 3		*	1712	1371	1.25	*
29. Brevard Co.-Indialantic/Melbourne		*	0	580		*
30. Brevard Co.-Cape Canveral			0	0		
31. Fort Pierce Beach, FL		*	426	1186	0.36	*
32. Duval Co., FL		*	2589	4160	0.62	*
33. Pinellas Co.-Long Key Segment		*	460	250	1.84	*
34. Pinellas Co.-Treasure Is. Segment		*	868	1000	0.87	*
35. Virginia Key and Key Biscayne		*	100	192	0.52	*
36. Dade Co.-BEC and Hurricane Protection		*	625	2110	0.30	*
37. Lee Co.-Captiva Island Segment			0	0		
38. Palm Beach Co.-Boca Raton Section			0	0		
39. Palm Beach Co.-Delray Beach Segment		*	2577	648	3.98	*
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet			0	0		
41. Manatee Co., FL			0	0		
42. Harrison Co., Mississippi	CESAM	*	3350	(3)		
DIVISION TOTALS - CESAD			**28773**	**22964**		
43. Grand Isle and Vicinity, LA	CELMN	*	1276	1520	0.84	*
44. Corpus Christi Beach, TX	CESWG	*	167	304	0.55	*
45. Galveston Seawall			0	0		
46. Presque Isle	CENCB	*	4028	4017	1.00	*
47. Lakeview Park Cooperative BEC, OH		*	16	80	0.20	*
48. Hamlin Beach State Park, OH		*	0	70		*
49. Point Place, OH			0	0		
50. Reno Beach, OH			0	0		
51. Maumee Bay		*	0	17		*
52. Surfside/Sunset	CESPL		0	0		
53. Oceanside		*	547	0		*
54. Channel Islands Harbor		*	30071	25600	1.17	*
55. Coast of CA, Point Mugu to San Pedro			0	0		
56. Ventura-Pierpont Area			0	0		
DIVISION TOTALS - Other Coastal			**36105**	**31608**		

Table 16

Periodic Nourishment, Volumes of Sand by Project

Footnotes:

(1) For these projects, information on actual periodic nourishment, and in some cases estimated periodic nourishment is not available. Periodic nourishment for these projects was the responsibility of the local sponsors, and NED office does not have any records indicating whether or not it was done.

(2) Estimates are not available for this project because whatever amount is removed from the navigation channel is placed on the beach to serve as a feeder beach.

(3) No estimates are available for the periodic nourishment for this project; all periodic nourishment is done by the local sponsor.

estimates within 10% of the actual. The volumes needed for periodic nourishment are more difficult to estimate than beach restoration fills because they are future projections that are based on average annual erosion rates, considering the probabilities of varying magnitude storms, tides, wave heights, winds, etc. Any low probability storm that has occurred historically over a limited history period adversely impacts the actual versus estimated comparison ratio. However in summary, 23 of the 33 projects discussed above; i e., 69.7 percent received less nourishment than originally estimated.

b. Adjusted Costs.

(1). Overview of Program. According to the survey of projects, 40 of the 56 projects involved periodic nourishment. These 40 projects are designated by an asterisk in the third column of Table 17. The total actual cost of periodic nourishment, adjusted to 1993 dollars, was $415.8 million. This was distributed across regions as follows: North Atlantic Division - 20%; South Atlantic Division - 44%; and other coastal divisions - 36%.

(2). Program Comparison. In order to present a comparison of the costs of periodic nourishment, those projects which had missing data had to be deleted. This was the case for seven of the older projects, most of which were build in the 1950's and the 1960's. This reduced the project list to 33 projects which could be compared. These 33 projects are indicated by an asterisk in the last column of Table 17. The total actual cost for these projects was $385.3 million in 1993 dollars. The estimated cost was $431.6 million in 1993 dollars. These figures result in an overall actual/estimated cost ratio for periodic nourishment of 0.89. This indicates that in the program as a whole, the actual costs of periodic nourishment have been less than the estimates by about 11%. If emergency costs are added to the actual periodic nourishment costs in this comparison, the actual/estimated ratio increases from 0.89 to 0.96. In many cases where emergency beach nourishment was done, the need for subsequent periodic nourishment was reduced for a period of time. A summary of the program overview and comparison is presented below.

Program Summary of Periodic Nourishment

Number of Projects	Actual ($ million 1993)	Estimated ($ million 1993)	Actual/Estimated Ratio
33	385.3	431.6	0.89
34 (Including emergency costs)	415.5	431.6	0.96

(3). Project Comparison. The costs of periodic nourishment, adjusted to 1993 dollars, for both actual and estimated values are shown in Table 17 for each individual project. The largest periodic nourishment project is Channel Islands Harbor, California, where the equivalent of $90.6 million, in 1993 dollars, has been spent thus far on periodic nourishment. For thirteen projects, there was either a zero in the actual or estimated column, resulting in either a ratio of zero or an undefined ratio, respectively. Therefore, meaningful ratios could be calculated for 20 projects, and these are also included in Table 17. These ratios indicate that actual periodic nourishment costs were higher than estimated in nine projects and lower than estimated in 11 projects. In seven of the twenty projects, the actual periodic nourishment costs were plus or minus 10 % of the estimated costs.

Table 17 - Periodic Nourishment, Adjusted Costs by Project

(continued on the next page)

Project	District	Projects With Periodic Nourishment	Updated Costs ($ thousands 1993)		Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
1. Prospect Beach, CT	CENED	*	(1)	3096		
2. Seaside Park, CT		*	(1)	3915		
3. Sherwood Island State Park, CT		*	(1)	990		
4. Quincy Shore Beach, MA			(1)	(1)		
5. Revere Beach, MA		*	0	720		*
6. Winthrop Beach, MA		*	(1)	1845		
7. Hampton Beach, NH		*	(1)	8379		
8. Wallis Sands State Beach, NH			0	0		
9. Cliff Walk, RI			0	0		
DIVISION TOTALS - CENED			**0**	**18945**		
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay	CENAN	*	26490	26638	0.99	*
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet		*	19616	(2)		
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach		*	0	1125		*
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton			0	0		
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		*	0	138		*
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		*	0	177		*
16. DE Coast Sand Bypass - Indian River	CENAP	*	719	2112	0.34	*
17. Cape May Inlet to Lower Township, NJ		*	0	5162		*
18. Great Egg Harbor Inlet and Peck Bch, NJ		*	0	4824		*
19. Atlantic Coast of MD-Ocean City, MD	CENAB	*	1196	0		*
20. Virginia Beach , VA	CENAO	*	27287	15530	1.76	*
DIVISION TOTALS - CENAD			**75308**	**55706**		
21. Wrightsville Beach, NC	CESAW	*	9087	8293	1.10	*
22. Carolina Beach and Vicinity, NC		*	23129	26560	0.87	*
23. Fort Macon, NC		*	0	450		*
24. Folly Beach	CESAC		0	0		
25. Tybee Island BEC	CESAS	*	7410	9474	0.78	*

Table 17 - Periodic Nourishment, Adjusted Costs by Project

(continued)

Project	District	Projects With Periodic Nourishment	Updated Costs ($ thousands 1993)		Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
26. Pinellas Co.-Sand Key Segment	CESAJ	*	0	3977		*
27. Broward Co.-Segment 2		*	20716	38451	0.54	*
28. Broward Co. and Hillsboro Inlet-Segment 3		*	24599	20830	1.18	*
29. Brevard Co.-Indialantic/Melbourne		*	0	6090		*
30. Brevard Co.-Cape Canveral			0	0		
31. Fort Pierce Beach, FL		*	3555	9072	0.39	*
32. Duval Co., FL		*	44196	57540	0.77	*
33. Pinellas Co.-Long Key Segment		*	3273	1680	1.95	*
34. Pinellas Co.-Treasure Is. Segment		*	9450	9148	1.03	*
35. Virginia Key and Key Biscayne		*	2545	4888	0.52	*
36. Dade Co.-BEC and Hurricane Protection		*	10939	23484	0.47	*
37. Lee Co.-Captiva Island Segment			0	0		
38. Palm Beach Co.-Boca Raton Section			0	0		
39. Palm Beach Co.-Delray Beach Segment		*	17752	16176	1.10	*
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet			0	0		
41. Manatee Co., FL			0	0		
42. Harrison Co., Mississippi	CESAM	*	10851	(3)		
DIVISION TOTALS - CESAD			**187502**	**236113**		
43. Grand Isle and Vicinity, LA	CELMN	*	8869	9807	0.90	*
44. Corpus Christi Beach, TX	CESWG	*	3686	3359	1.10	*
45. Galveston Seawall			0	0		
46. Presque Isle	CENCB	*	47199	46938	1.01	*
47. Lakeview Park Cooperative BEC, OH		*	133	682	0.20	*
48. Hamlin Beach State Park, OH		*	0	1080		*
49. Point Place, OH			0	0		
50. Reno Beach, OH			0	0		
51. Maumee Bay		*	0	187		*
52. Surfside/Sunset	CESPL		0	0		
53. Oceanside		*	2482	0		*
54. Channel Islands Harbor		*	90624	77056	1.18	*
55. Coast of CA, Point Mugu to San Pedro			0	0		
56. Ventura-Pierpont Area			0	0		
DIVISION TOTALS - Other Coastal			152993	139109		

Table 17

Periodic Nourishment, Adjusted Costs by Project

Footnotes:

(1) For these projects, information on actual periodic nourishment, and in some cases estimated periodic nourishment, is not available. Periodic nourishment for these projects was the responsibility of the local sponsors, and NED office does not have any records indicating whether or not it was done.

(2) Estimates are not available for periodic nourishment for this project because whatever amount is removed from the navigation channel is placed on the beach to serve as a feeder beach.

(3) No estimates are available for periodic nourishment for this project; all periodic nourishment is done by the local sponsor.

6. STRUCTURES - ADJUSTED COSTS

a. Overview of Program. The majority (42) of the 56 Congressionally authorized shore protection projects had structural components. These are indicated with an asterisk in the third column of Table 18. There were only six projects which consisted of structural elements without beach fill. The total cost of fixed structures in the Federal shore protection program in 1993 dollars was $308.5 million. These costs are distributed across the regions as follows: 40% in North Atlantic division; 11% in South Atlantic Division; and 49% in other coastal divisions.

b. Program Comparison. In order to present a comparison of structural costs, those projects which had missing data had to be deleted. This reduced the project list to 35 projects which could be compared. These 35 projects are designated by an asterisk in the last column of Table 18. The actual cost of the 35 projects was $298.6 million in 1993 dollars and the estimated cost was $311.4 million in 1993 dollars. This resulted in an overall program actual/estimated ratio for structural costs of 0.96. This indicates that considering the structural program as a whole, actual costs were slightly less than estimated costs (by about 4%). A summary of the program overview and comparison is presented below.

Program Summary of Structures

Number of Projects	Actual ($ million 1993)	Estimated ($ million 1993)	Actual/Estimated Ratio
35	298.6	311.4	0.96

c. Project Comparison. The costs of structures, both actual and estimated,are presented by individual project in Table 18. Actual/estimated cost ratios have also been calculated for the 35 projects where there was sufficient information. Fourteen of these ratios are greater than one, indicating that actual costs were higher than estimated costs. One ratio is equal to unity, indicating that actual and estimated costs were equal. And for the 20 remaining projects, actual costs were less than estimated.

The project having the largest expenditures for structural measures was the Raritan Bay and Sandy Hook Bay project at Keansburg and East Keansburg, NJ, where $80.2 million, in 1993 dollars, were spent on fixed structures. The second largest structural project was the Galveston Seawall in Texas, which cost $53.2 million 1993 dollars.

Table 18 - Structures, Adjusted Costs by Project

(continued on the next page)

Project	District	Projects with Stuctures	Updated Costs ($ thousands 1993)		Actual/Estimated Ratio	Projects included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
1. Prospect Beach, CT	CENED	•	441	334	1.32	•
2. Seaside Park, CT			0	0		
3. Sherwood Island State Park, CT		•	135	1849	0.07	•
4. Quincy Shore Beach, MA		•	5646	2596	2.17	•
5. Revere Beach, MA			0	0		
6. Winthrop Beach, MA		•	1382	2815	0.49	•
7. Hampton Beach, NH		•	707	154	4.59	•
8. Wallis Sands State Beach, NH		•	302	393	0.77	•
9. Cliff Walk, RI		•	1715	6555	0.26	•
DIVISION TOTALS - CENED			**10328**	**14696**		
10. Atlantic Coast of NYC, E. Rockaw Inlet to Rockaway Inlet and Jama	CENAN	•	2439	(1)		
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet			0	0		
12. S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach		•	20136	22082	0.91	•
13. S. Shore of Long Is. Fire Is. to Montauk Point Southhampton to Beach Hampton		•	2962	3739	0.79	•
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships		•	812	895	0.91	•
15. Raritan Bay and Sandy Hook Bay, NJ Keansburg and E. Keansburg, NJ		•	80231	23964	3.35	•
16. DE Coast Sand Bypass - Indian River	CENAP	•	2069	1133	1.83	•
17. Cape May Inlet to Lower Township, NJ		•	3618	3188	1.13	•
18. Great Egg Harbor Inlet and Peck Bch, NJ		•	2287	1001	2.28	•
19. Atlantic Coast of MD-Ocean City, MD	CENAB	•	6280	8208	0.77	•
20. Virginia Beach , VA	CENAO		0	0		
DIVISION TOTALS - CENAD			**120834**	**64210**		
21. Wrightsville Beach, NC	CESAW		0	0		
22. Carolina Beach and Vicinity, NC		•	194	(1)		
23. Fort Macon, NC		•	3852	3041	1.27	•
24. Folly Beach	CESAC	•	1609	2924	0.55	•
25. Tybee Island BEC	CESAS	•	2681	2228	1.20	•

Table 18 - Structures, Adjusted Costs by Project

(continued)

Project	District	Projects with Stuctures	Updated Costs ($ thousands 1993)		Actual/Estimated Ratio	Projects Included in the Overall Actual/Estimated Ratio
			Actual	Estimated		
26. Pinellas Co.-Sand Key Segment	CESAJ	*	1443	(1)		
27. Broward Co.-Segment 2			0	0		
28. Broward Co. and Hillsboro Inlet-Segment 3		*	0	475		
29. Brevard Co.-Indialantic/Melbourne			0	0		
30. Brevard Co.-Cape Canveral			0	0		
31. Fort Pierce Beach, FL			0	0		
32. Duval Co., FL			0	0		
33. Pinellas Co.-Long Key Segment		*	1139	(1)		
34. Pinellas Co.-Treasure Is. Segment		*	1429	(1)		
35. Virginia Key and Key Biscayne		*	3472	5688	0.61	*
36. Dade Co.-BEC and Hurricane Protection		*	7402	3698	2.00	*
37. Lee Co.-Captiva Island Segment			0	0		
38. Palm Beach Co.-Boca Raton Section			0	0		
39. Palm Beach Co.-Delray Beach Segment			0	0		
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet		*	3906	3480	1.12	*
41. Manatee Co., FL			0	0		
42. Harrison Co., Mississippi	CESAM	*	6646	6646	1.00	*
DIVISION TOTALS - CESAD			**33773**	**28180**		
43. Grand Isle and Vicinity, LA	CELMN	*	2300	1876	1.23	*
44. Corpus Christi Beach, TX	CESWG	*	361	498	0.72	*
45. Galveston Seawall		*	53210	105896	0.50	*
46. Presque Isle	CENCB	*	23983	27649	0.87	*
47. Lakeview Park Cooperative BEC, OH		*	1680	2941	0.57	*
48. Hamlin Beach State Park, OH		*	2964	3329	0.89	*
49. Point Place, OH		*	17794	13888	1.28	*
50. Reno Beach, OH		*	6750	8465	0.80	*
51. Maumee Bay		*	832	1268	0.66	*
52. Surfside/Sunset	CESPL	*	4481	5123	0.87	*
53. Oceanside		*	1181	911	1.30	*
54. Channel Islands Harbor		*	21613	29181	0.74	*
55. Coast of CA, Point Mugu to San Pedro	(2)	*	3261	1205		
56. Ventura-Pierpont Area		*	3163	3739	0.85	*
DIVISION TOTALS - Other Coastal			**143573**	**205969**		

Table 18

Structures, Adjusted Costs by Project

Footnotes:

(1) For these projects, estimates were not available for structures because they were not part of the original project.

(2) The estimates for structures for this project are only partial figures; they do not include all of the structures which were actually constructed.

7. EMERGENCY REPAIRS AND COSTS

Public Law 84-99 authorized an emergency fund to be used: 1) in the protection of Federally authorized hurricane or shore protection projects being threatened when in the discretion of the Chief of Engineers such protection is warranted to protect against imminent and substantial loss to life and property; and 2) in the repair and restoration of any Federally authorized hurricane or shore protective structures damaged or destroyed by wind, wave, or water action of other than an ordinary nature when in the discretion of the Chief of Engineers such repair and restoration is warranted for the adequate functioning of such projects. Emergency repairs and costs are totally; i.e., 100% a Federal responsibility and accordingly, are not applicable to conditions or proportions of damage arising from deferred maintenance or expected beach nourishment demands. For example, if a beach fill project, having an expected nourishment requirement of 100,000 cubic yards of sand per year, experiences a loss of 200,000 cubic yards of sand as a result of a major storm occurring 1-year after project completion, emergency repairs and related costs would apply only to 100,000 cubic yards of material. The remaining 100,000 cubic yards of sand necessary to fully restore the project fill would have to be cost-shared with the project's conditions of local cooperation. A total of $30.2 million in 1993 dollars has been spent on emergency repairs and/or emergency beach nourishment (Table 19). More than half of this has been spent in the South Atlantic Division. Ten of the 56 projects qualified for emergency repairs. If all of these emergency costs were added to the actual periodic nourishment costs in the actual/estimated cost comparison, the actual/estimated ratio for the whole program would increase from 0.89 to 0.96. It is remarked that no disaster assistance funds under programs of the Federal Emergency Management Agency (FEMA) are used in the emergency repair of Federally authorized shore protection projects administered by the U.S. Army Corps of Engineers.

Table 19
Emergency Costs by Project

Project Name	Emergency Costs ($ thousands 1993)
Atlantic Coast of NYC - Rockaway	3399
DE Coast Sand Bypass	109
Ocean City, MD	1950
Virginia Beach, VA	2169
Wrightsville Beach, NC	2755
Carolina Beach, NC	5209
Tybee Island, GA	355
Pinellas Co. FL - Treasure Island	8518
Grand Isle, LA	5014
Ventura-Pierpont, CA	682
Total	30160

8. ADJUSTED COSTS, BY YEAR

a. Historical Pattern, Entire Program. The yearly costs of the Federal shore protection program, converted to 1993 dollars, are contained in Table 20, and illustrated graphically in Figure 5. Since these costs are adjusted to a common level; i.e., 1993 dollars, Figure 5 depicts the relative changes in spending on shore protection projects over the 1950 to 1993 period. It is evident that both Federal and total expenditures have varied considerably from year to year. The peak in total expenditures, $91.5 million, occurred in 1980. This was followed by lower spending in the 1980's, and rising costs in the early 1990's. Total program costs over the 44 year period of evaluation, in 1993 dollars, were $1,489.5 million.

Figure 5 - Expenditures by Year 1950-1993
Adjusted to 1993 Dollars

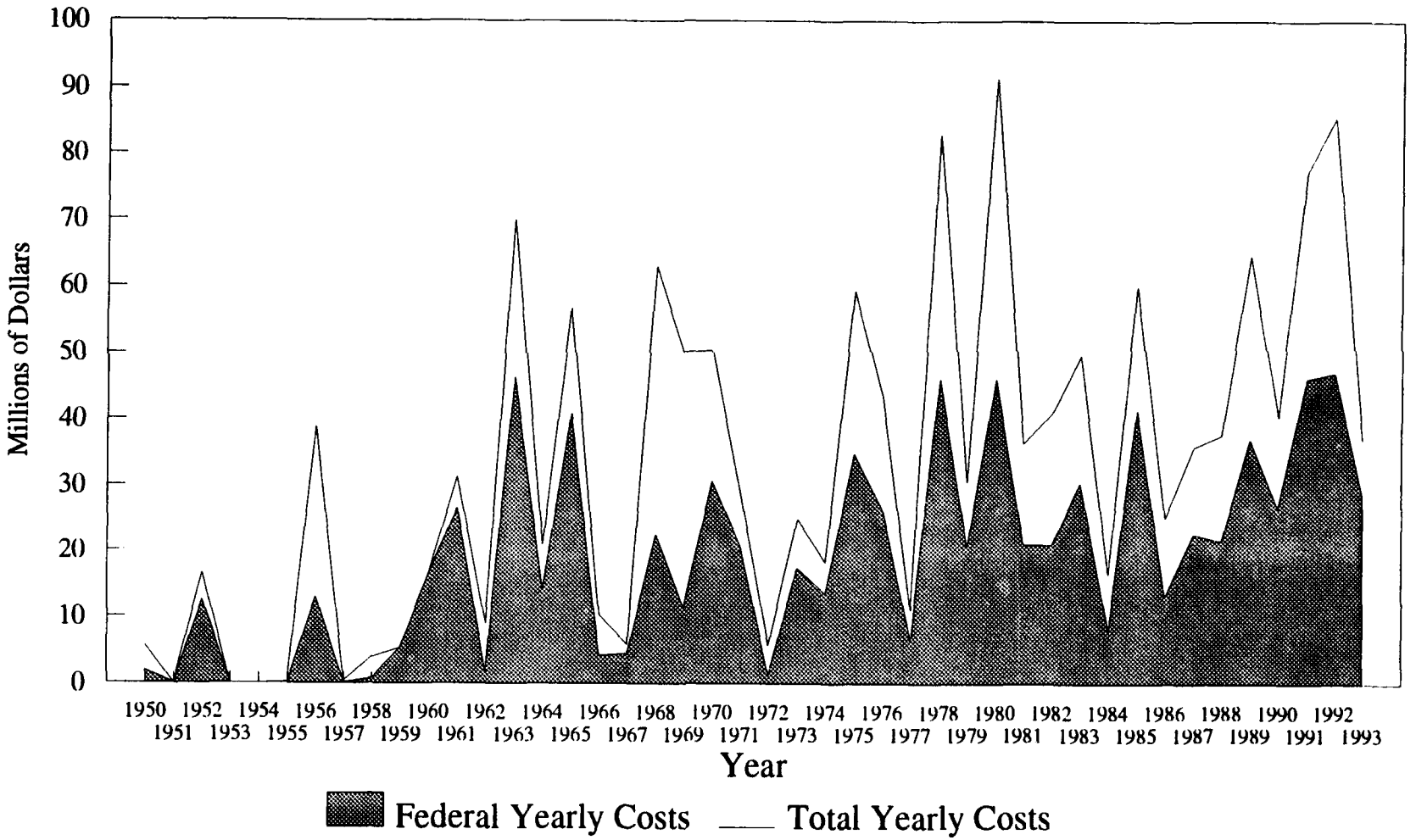


Table 20 - Adjusted Expenditures by Year, 1950-1993
($ thousands 1993)
(continued on next page)

Year	Initial Beach Restoration		Periodic Nourishment	
	Federal Costs	Total Costs	Federal Costs	Total Costs
1950	0	0	0	0
1951	0	0	0	0
1952	9975	9975	0	0
1953	0	0	0	0
1954	0	0	0	0
1955	0	0	0	0
1956	11390	34174	0	0
1957	0	0	0	0
1958	0	0	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	18760	18760	7319	10455
1962	198	595	0	4988
1963	3631	10892	5985	5985
1964	13153	19518	733	1466
1965	13915	21590	15695	18278
1966	1849	4384	1405	2708
1967	1242	1763	1638	2781
1968	4888	8556	14580	14941
1969	7294	12183	89	89
1970	18617	32158	1647	2619
1971	10041	16046	10539	12625
1972	0	0	1258	5796
1973	6060	10356	10302	12667
1974	6103	7663	3345	4853
1975	25091	45885	6708	7668
1976	22516	36454	3466	6176
1977	3732	7038	1585	2495
1978	40350	71301	5400	11024
1979	12290	21604	8321	9004
1980	41632	82335	4554	9193
1981	12382	24693	7480	9251
1982	10975	21520	9441	18583
1983	712	1017	16608	29012
1984	0	0	7480	15453
1985	23614	32227	17459	27147
1986	0	0	9892	20142
1987	0	0	22290	35136
1988	6257	12346	13413	22973
1989	22817	46793	13176	16584
1990	12958	19420	11267	18274
1991	20901	33427	21093	35390
1992	24146	41399	8040	16796
1993	22677	28925	4491	5252
TOTAL	430166	734997	266699	415803

Table 20 - Adjusted Expenditures by Year, 1950-1993
($ thousands 1993)
(continued)

Year	Structures		Total Project Costs	
	Federal Costs	Total Costs	Federal	Total
1950	1863	5646	1863	5646
1951	0	0	0	0
1952	2501	6646	12476	16621
1953	0	0	0	0
1954	0	0	0	0
1955	49	148	49	148
1956	1571	4718	12961	38892
1957	134	441	134	441
1958	751	3906	751	3906
1959	5270	5270	5270	5270
1960	16343	16343	16343	16343
1961	395	2007	26474	31222
1962	1537	3463	1735	9046
1963	36850	53210	46466	70087
1964	253	5	14139	20989
1965	11198	16906	40808	56774
1966	966	3169	4220	10261
1967	1600	1331	4480	5875
1968	3030	39507	22498	63004
1969	4022	37839	11405	50111
1970	10386	15575	30650	50352
1971	59	159	20639	28830
1972	3	3	1261	5799
1973	1082	1835	17444	24858
1974	4085	5836	13533	18351
1975	3022	5841	34820	59394
1976	406	811	26388	43441
1977	1176	1680	6493	11213
1978	456	671	46206	82996
1979	0	0	20611	30608
1980	0	0	46186	91528
1981	1219	2439	21081	36383
1982	534	912	20950	41015
1983	13062	19644	30382	49673
1984	535	1069	8015	16522
1985	402	804	41475	60178
1986	3128	4908	13020	25050
1987	319	638	22609	35774
1988	1870	2300	21540	37619
1989	1003	1308	36996	64685
1990	2355	2821	26580	40515
1991	4215	8548	46209	77365
1992	14833	27408	47019	85603
1993	1368	2743	28536	36920
TOTAL	**153850**	**308506**	**850712**	**1459306**

b. Historical Pattern by Project Element. Table 20 also presents the adjusted historical costs by project elements. The highest expenditure on fixed structures occurred in 1963, and spending on structural components has generally declined since then. Initial beach restoration costs reached a peak of $82.3 million in 1980, and have since declined.

9. EXPECTED FUTURE COSTS ASSOCIATED WITH MAINTENANCE (INCLUDING PERIODIC NOURISHMENT) OF ALREADY-CONSTRUCTED FEDERALLY-SUPPORTED PROJECTS

Table 21 and Figure 6 show the projected Federal and total costs of maintaining the 56 large, Congressionally authorized shore protection projects which have been discussed. These costs are in large measure associated with periodic nourishment. The Federal share of these costs will remain essentially at the same level ($10 to $20 million) for the next 35 years. Committed costs begin to decline after the year 2033, and reach a nil point by the year 2048 when all existing project authorizations for Federal participation will have expired.

10. COST ESTIMATES FOR PROJECTS IN THE PLANNING STAGES

The survey revealed that there are presently 26 projects which are far enough in the planning process to have cost estimates. These projects are listed in Table 22, and the cost estimates, in 1993 dollars, are by project element. Four of these potential projects are projected to be over 100 million dollars in total costs. The majority are beach nourishment type projects. Based on a cost sharing percentage of 65/35, the Federal share of these costs would be approximately $1,080.6 million in 1993 dollars.

Figure 6 - Expected Future Costs Associated with Already Constructed Projects

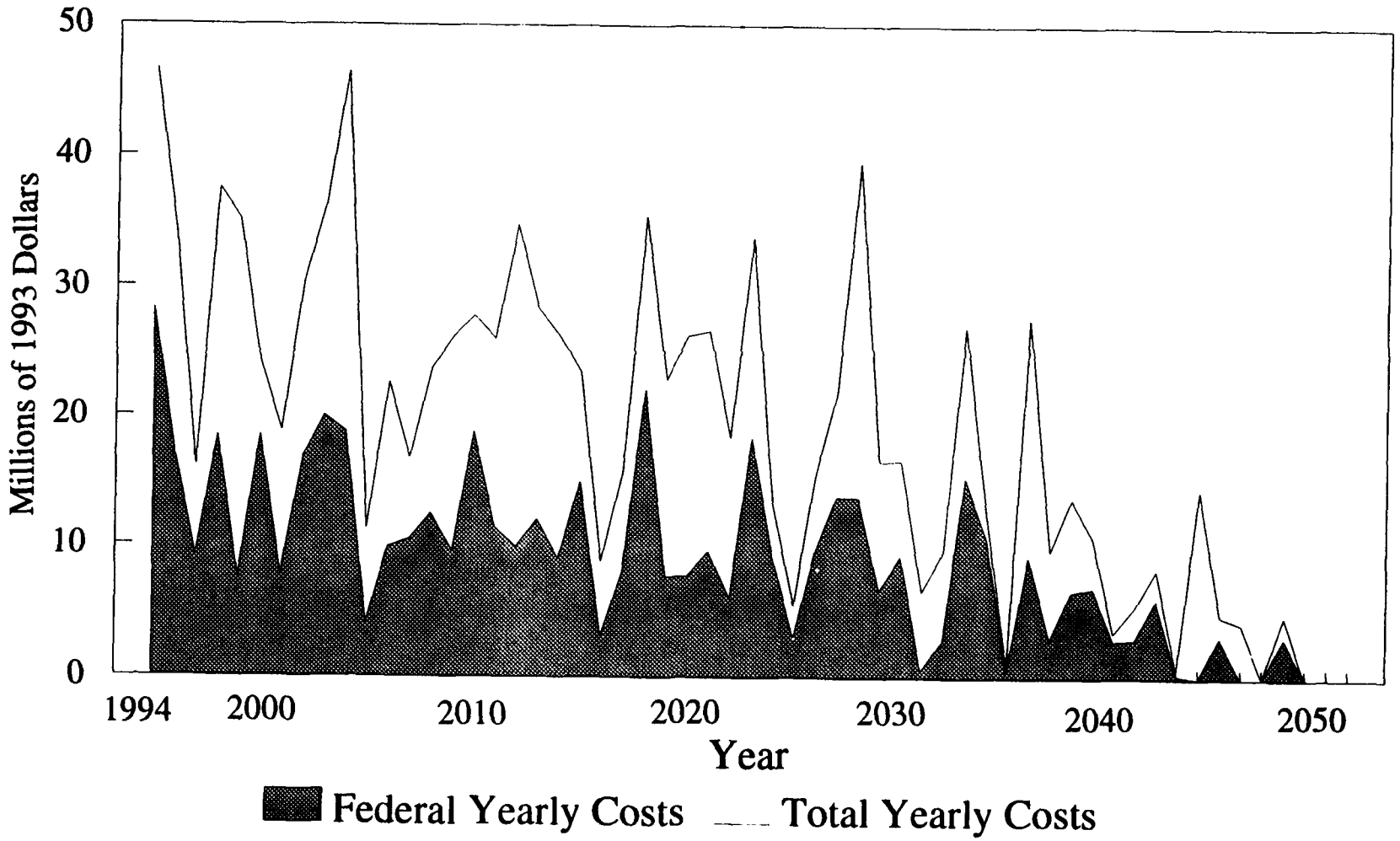


Table 21 - Expected Future Costs Associated With Already Constructed Projects ($ thousands 1993)
(continued on next page)

Year	Initial Beach Restoration		Periodic Nourishment	
	Federal costs	Total Costs	Federal Costs	Total Costs
1994	4650	7150	23513	39314
1995	7719	17576	9208	16552
1996	0	0	9089	15996
1997	0	0	18319	37383
1998	0	0	7486	35083
1999	0	0	10560	15327
2000	0	0	7571	18630
2001	0	0	16609	30219
2002	0	0	19812	36037
2003	0	0	18561	46170
2004	0	0	3882	11087
2005	0	0	9705	22404
2006	0	0	10280	16520
2007	0	0	12202	23487
2008	0	0	9388	25918
2009	0	0	18542	27574
2010	0	0	11213	25822
2011	0	0	9705	34542
2012	0	0	11786	28192
2013	0	0	8827	26057
2014	0	0	14702	23230
2015	0	0	2940	8642
2016	0	0	7931	15539
2017	0	0	21911	35286
2018	0	0	7486	22732
2019	0	0	7522	26075
2020	0	0	9388	26398
2021	0	0	5833	18192
2022	0	0	18122	33595
2023	0	0	9068	13153
2024	0	0	2794	5336
2025	0	0	9352	15162
2026	0	0	13572	21662
2027	0	0	13534	39313
2028	0	0	6479	16329
2029	0	0	9026	16360
2030	0	0	342	6418
2031	0	0	2665	9354
2032	0	0	15078	26761
2033	0	0	10474	12452
2034	0	0	342	683
2035	0	0	9026	27397
2036	0	0	2752	9476
2037	0	0	6392	13427
2038	0	0	6703	10469
2039	0	0	2665	3264
2040	0	0	2752	5233
2041	0	0	5785	8064
2042	0	0	295	590
2043	0	0	0	14347
2044	0	0	3120	4800
2045	0	0	0	4175
2046	0	0	0	0
2047	0	0	3120	4800
2048	0	0	0	0
2049	0	0	0	0
2050	0	0	0	0
TOTAL	12369	24726	477415	1031005

Table 21 - Expected Future Costs Associated With Already Constructed Projects ($ thousands 1993) (continued)

Year	Structures		Total Project Costs	
	Federal Costs	Total Costs	Federal	Total
1994	86	105	28249	46569
1995	86	105	17013	34233
1996	86	115	9175	16111
1997	86	105	18405	37488
1998	86	105	7572	35168
1999	7900	8778	18460	24105
2000	172	190	7743	18820
2001	172	190	16781	30409
2002	172	190	19984	36227
2003	172	190	18733	46360
2004	172	190	4054	11277
2005	172	190	9877	22594
2006	172	200	10452	16720
2007	172	190	12374	23677
2008	172	190	9560	26108
2009	172	190	18714	27764
2010	172	190	11385	26012
2011	172	190	9877	34732
2012	172	190	11958	28382
2013	172	190	8999	26247
2014	172	190	14874	23420
2015	172	190	3112	8832
2016	172	200	8103	15739
2017	172	190	22083	35476
2018	172	190	7658	22922
2019	172	190	7694	26265
2020	172	190	9560	26588
2021	172	190	6005	18382
2022	172	190	18294	33785
2023	172	190	9240	13343
2024	172	190	2966	5526
2025	172	190	9524	15352
2026	172	200	13744	21862
2027	172	190	13706	39503
2028	172	190	6651	16519
2029	172	190	9198	16550
2030	172	190	514	6608
2031	172	190	2837	9544
2032	172	190	15250	26951
2033	172	190	10646	12642
2034	172	190	514	873
2035	172	190	9198	27587
2036	172	190	2924	9666
2037	172	190	6564	13617
2038	172	190	6875	10659
2039	172	190	2837	3454
2040	172	190	2924	5423
2041	172	190	5957	8254
2042	0	0	295	590
2043	0	0	0	14347
2044	0	0	3120	4800
2045	0	0	0	4175
2046	0	0	0	0
2047	0	0	3120	4800
2048	0	0	0	0
2049	0	0	0	0
2050	0	0	0	0
TOTAL	15554	17323	505338	1073054

Table 22 - Projects Which Are Planned, But Not Constructed
Estimated Total Costs ($ thousands 1993)

Project	Category	Intial Beach Restoration	Periodic Nourishment	Structures	Total
1. Homer Spit, AK	Under Construction	Spent: 0 Remaining: 0	0 9600	5300 0	5300 9600
Total - Under Construction		**0**	**9600**	**5300**	**14900**
2. Atlantic Coast of NYC, Rockaway Inlet to Norton Point (Coney Island Area)	Authorized/Awaiting Initiation of Construction	11332	19680	5700	36712 0
3. Atlantic Coast of NJ, Sandy Hook to Barnegat Inlet (Seabright)		183828	210238	0	394066 0
4. Virginia Beach, VA (1)					
5. South of Carolina Beach (Kure Beach), NC		17162	71440	0	88602
6. Broward Co.,FL: Segment 1		11200	35000	0	46200
7. Pinellas Co., FL: Clearwater Beach Is. Segment		1480	9960	0	11440
8. Lee Co., FL: Estero Segment		2626	29288	718	32632
9. Lee Co., FL: Gasparilla Island		4630	15788	3887	24305
10.Palm Beach Co.,FL: Ocean Ridge Reach		4130	24180	28317	56627
11.Charlotte Co., FL		1831	6840	0	8671
Total - Authorized/Awaiting Initiation of Construction		**238219**	**422414**	**38622**	**699255**
12.Atlantic Coast of NJ, Sandy Hook to Barnegat Inlet (Asbury Park)	Preconstruction Engineering Design (PED)	48983	32789	0	81772
13.Willoughby Spit, Norfolk, VA		6305	1844	0	8149
14.Fort Fisher, NC		0	0	11156	11156
15.Myrtle Beach, SC		50724	67713	0	118437
16.Martin Co., FL		10583	39960	0	50543
17.Monroe Co., FL: Beach Erosion Control		1326	3700	0	5026
18.Nassau Co., FL		12713	34675	0	47388
19.St. Johns, Co. FL		22560	61160	0	83720
20.Indian River Co., FL: Sebastian Segment		0	23788	0	23788
21.Indian River Co., FL: Vero Beach Segment		12568	33360	0	45928
22 Sarasota Co.,FL: Longboat Key & Venice Bch		23091	32815	0	55906
23.Palm Beach Co., FL: (62) South Lake Worth Sand Transfer Plant		7242	24882	0	32124 0
24.Panama City Beaches, FL		136000	58500	18936	213436
25.Gulf Intercoastal Waterway, Sargent Beach, TX		0	0	108129	108129
26.Indiana Shoreline Erosion, IN		5914	56923	0	62837
Total - Preconstruction Engineering and Design		**338009**	**472109**	**138221**	**948339**
Total - Planned		**576228**	**904123**	**182143**	**1662494**

Footnote: (1) *Virginia Beach future estimates are included in the yearly totals of Table 21.*

11. SUMMARY

To sum up, in the 56 large specifically authorized Corps shore protection projects examined in detail in this section, 110.6 million cubic yards of sand were placed for initial beach restoration, 79.1 million cubic yards of sand were placed for periodic nourishment, yielding a total volume of sand placed of 189.7 million cubic yards.

Total expenditures to date on these projects have been $670.3 million, with a Federal share of $403.3 million. If these expenditures are adjusted to 1993 dollars, the figures become $1,489.5 million total and $880.9 million Federal. Expected Federal future maintenance costs associated with the 56 already-constructed projects are $505.3 in 1993 dollars, and these will be spread over approximately the next 50 years. Cost estimates for 26 projects which are currently under construction, authorized/awaiting initiation of construction, or in the preconstruction engineering design stage total $1,662.5 million in 1993 dollars. The Federal share of this is expected to be 65%.

Actual/estimated comparisons have been made for five aspects of the shore protection projects: initial beach restoration - volumes of sand; initial beach restoration - costs; periodic nourishment - volumes of sand; periodic nourishment - costs; and structures - costs. Comparisons were performed for the program as a whole as well as for individual projects. Looking at the program as a whole, actual volumes of sand and costs were consistently within approximately ten percent of the estimates. For individual projects there was more variation between actuals and estimates. However, as evidenced by Table 23 approximately equal numbers of projects had actuals higher than estimates as had actuals lower than estimates.

Table 23
Summary of Individual Project Actual/Estimated Comparisons by Project Element

Project Element	Projects with Actuals Higher than Estimates	Projects with Actuals lower than Estimates
Initial Beach Restoration-Sand	22	13
Initial Beach Restoration- Cost	19	17
Periodic Nourishment- Sand	7	13
Periodic Nourishment- Cost	9	11
Structures - Cost	14	20
All Elements	72	73

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APPENDIX A

STUDY QUESTIONNAIRE

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

21 Jun 1993

CEWRC-IWR-P

MEMORANDUM FOR See Distribution

SUBJECT: Shoreline Protection and Beach Erosion Study

1. The purpose of this memorandum is to inform you of a new study that was directed by the Office of Management and Budget (OMB) in the Fiscal Year 1994 Passback. OMB has requested that the "Army should conduct an analysis of the economic and environmental effectiveness of storm damage protection projects. The study should seek to compare and contrast the estimates of project benefits, costs, and environmental effects with current and projected conditions. The study should include a comparison of the anticipated and actual level of protection as well as an analysis of any induced development effects. OMB should be consulted throughout the study process."

2. The study will be completed in two phases. Phase I will concentrate on analysis of costs. Your assistance is requested in providing the basic project description and cost data for shore protection projects in your division through the enclosed questionnaire and tables. This study applies to all Congressionally authorized studies and projects. Upon receipt and analysis of these data, a report on phase I will be prepared and provided to the Acting Assistant Secretary of the Army for Civil Works by 31 August 1993. The data will also be placed in a computerized data base which can be expanded and updated as required.

3. The findings of this study could result in national shore protection policy decisions that may shape the future U.S. Army Corps of Engineers shore protection program. It is therefore extremely important that this effort thoroughly and accurately identifies pertinent empirical data. Your prompt and careful completion of the questionnaire is an essential part of the study.

4. The second phase of the study will include a comparison of anticipated and actual benefits of the projects as well as analysis of any induced development effects. A copy of the complete scope of work is enclosed for your information.

5. A task force of selected Corps shore protection evaluation experts from the North Atlantic and South Atlantic Divisions, the Coastal Engineering Research Center, HQUSACE and the Institute for Water Resources (IWR) has been formed to assist in methodology development and analyses necessary to research the areas of OMB concern. The first meeting of this task force was held at IWR on 2-3 June 1993. The enclosed questionnaire was developed by the task force.

CEWRC-ZA
SUBJECT: Shoreline Protection and Beach Erosion Study

6. In addition to a copy of the questionnaire and tables, we have enclosed an electronic form of the questionnaire in a Lotus format. Please use whichever form is most convenient for you. We have also included examples of completed forms.

7. I ask each division to:

a. advise the IWR point of contact, Ted Hillyer (703/355-2140, fax - 3171), or his alternate Anne Sudar (703/355-2336, fax-3171) of the name of a principal and alternate point of contact;

b. return the required information to CEWRC-IWR-P Attn: Ted Hillyer by 19 July 1993. Completed questionnaires may be returned to IWR on a project by project basis when available.

8. The above individuals may be contacted in relation to completion of the questionnaire, as well as Donald Barnes, CECW-PA (202/272-0120) on any methodology or policy concerns on this study.

Enclosures

STANLEY G. GENEGA
Brigadier General (P), USA
Director of Civil Works

DISTRIBUTION (See Page 3)

CEWRC-ZA
SUBJECT: Shoreline Protection and Beach Erosion Study

DISTRIBUTION
COMMANDER
LOWER MISSISSIPPI VALLEY
NEW ENGLAND
NORTH ATLANTIC
NORTH CENTRAL
NORTH PACIFIC
PACIFIC OCEAN
SOUTH ATLANTIC
SOUTH PACIFIC
SOUTHWESTERN

CF:
COMMANDER
NEW ORLEANS
BALTIMORE
NEW YORK
NORFOLK
PHILADELPHIA
BUFFALO
CHICAGO
DETROIT
ST. PAUL
ALASKA
PORTLAND
SEATTLE
CHARLESTON
JACKSONVILLE
MOBILE
SAVANNAH
WILMINGTON
LOS ANGELES
SAN FRANCISCO
GALVESTON

Cost Recovery Questionnaire on Shoreline Protection and Beach Erosion Control Projects/Studies

June 16 draft

(Please complete one questionnaire for each project/study)

1. **District**: _____

2. Project/Study **Name**: _____
   (Name as in Authorizing Document or Resolution)

3. **Location**: Waterbody _____

   State _____

   County _____

   City(ies) _____(list all)

4. Project/Study **Purpose**: (circle all that apply)

   1 - Hurricane and/or Storm Damage Reduction

   2 - Recreation

   3 - Beach Erosion Control

   4 - Environmental Restoration

   5 - Navigation

   6 - Mitigation

5. **Need** for the Project/Study and Value of Front Row Development

Please include (on a separate sheet if necessary) a narrative describing the need for the project (i.e. highlight particular storm events, historic damages, other problems, etc. which triggered the study authorization, project authorization, and project construction, as applicable). Also, if possible, provide a dollar figure (be sure to include the year and price level) of the front row development in the project/study area. If a roadway is located directly landward of the project, include the first row of development behind the roadway in this estimate.

6. **Type** of Project/Study: (circle all that apply)

1 - Initial restoration

2 - Periodic nourishment

3 - Groin Field

4 - Sand Bypassing

5 - Terminal Groin

6 - Breakwater

7 - Revetments (including seawalls and bulkheads)

8 - Tidal Surge Protection

7. **Authorization** Citation (including date): _____
(Public Law or House or Senate Resolution)

8. Project/Study **Status**: (circle one)

1 - Reconnaisance

2 - Feasibility

3 - Preconstruction Engineering Design

4 - Authorized/Awaiting Funds

5 - Under Construction

6 - Construction Complete except for Periodic Nourishment

7 - Deauthorized

9. Is there an **O & M Manual**?

- Yes - No

10. If no, is there periodic monitoring and/or inspection?

- Yes - No

11. What is the frequency of monitoring and/or inspection? _____

12. Reason for Difference Between Estimated Cost and Actual Cost for the Project

If applicable, please indicate in a narrative (on a separate sheet of paper), the reasons for the difference between the estimated cost and the actual cost of the project construction (i.e. new environmental restrictions, storm occurred during construction, etc.).

Initial Engineering Data for the Project/Study

(from last report approved prior to construction, may be Feasibility report, GDM, GRR, LRR, DM)

General:

13. Length of Project: _____

14. Pre/project average recession rate: _____ feet/year

15. Period of Comparison for recession rate: _____

16. Vertical Datum: _____

For Beach Nourishment Projects/Studies:

17. Number of Berms: _____
(Note: if multiple berms are of different sizes, attach an additional sheet.)

18. Berm Height: _____

19. Berm Width: _____

20. Dune Height: _____

21. Dune Width: _____

22. Average High Water Shoreline Extension: _____

23. Predicted Depth Limit of Adjusted Fill: _____

For Protective Structures:

24. Number of protective structures: _____
(Note: if multiple structures are of different types, and different sizes, please attach additional sheets with details on each one.)

25. Type of Structure: _____

26. Structure Height: _____

27. Structure Length: _____

28. Structure Spacing (groins or breakwaters): _____

29. Construction Material: _____

30. **Point of Contact:** Name: _____

Office Symbol: _____

Phone Number: _____

Fax Number: _____

SHORELINE PROTECTION AND BEACH EROSION CONTROL STUDY

UPDATE FACTORS FOR STRUCTURAL PROJECTS

TO DEVELOP OCTOBER 1993 PRICES

Year	Update Factor	Year	Update Factor	Year	Update Factor
1906	54.1	1936	25.0	1966	5.04
1907	50.9	1937	21.9	1967	4.79
1908	53.0	1938	21.8	1968	4.45
1909	56.5	1939	21.8	1969	4.05
1910	53.5	1940	21.2	1970	3.72
1911	55.3	1941	19.9	1971	3.25
1912	56.5	1942	18.6	1972	2.93
1913	51.4	1943	17.7	1973	2.71
1914	57.8	1944	17.2	1974	2.54
1915	55.3	1945	16.7	1975	2.23
1916	39.5	1946	14.9	1976	2.14
1917	28.4	1947	12.4	1977	2.00
1918	27.2	1948	11.1	1978	1.85
1919	26.0	1949	10.8	1979	1.71
1920	20.5	1950	10.1	1980	1.59
1921	25.4	1951	9.47	1981	1.45
1922	29.5	1952	9.03	1982	1.34
1923	24.0	1953	8.57	1983	1.26
1924	23.9	1954	8.18	1984	1.24
1925	24.8	1955	7.79	1985	1.23
1926	24.7	1956	7.43	1986	1.20
1927	25.0	1957	7.10	1987	1.17
1928	24.8	1958	6.77	1988	1.14
1929	24.8	1959	6.45	1989	1.11
1930	25.3	1960	6.24	1990	1.09
1931	28.4	1961	6.07	1991	1.06
1932	32.7	1962	5.89	1992	1.03
1933	30.2	1963	5.70	1993	1.00
1934	26.0	1964	5.49		
1935	26.2	1965	5.29		

Update factors based on the Engineering News Record Construction Construction Cost Index. Base year 1913=100.

Project Name:_____ Price Level: _____

Table 1. CONSTRUCTION COST ESTIMATE
(From most recently approved Report, Feasibility, GDM, GRR, LRR or DM? _____)

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				
		Yards^3 (000)	Borrow Source	Cost (000)		Yards^3 (000)	Borrow Source	Cost (000)		CONSTRUCTION Materials	Cost (000)		O&M COSTS (000)	
				Fed	Total			Fed	Total		Fed	Total	Fed	Total
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Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				
		Yards^3 (000)	Borrow Source	Cost (000)		Yards^3 (000)	Borrow Source	Cost (000)		CONSTRUCTION Materials	Cost (000)		O&M COSTS (000)	
				Fed	Total			Fed	Total		Fed	Total	Fed	Total
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Initial Estimates (continued)

Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				
		Yards^3 (000)	Borrow Source	Cost (000)		Yards^3 (000)	Borrow Source	Cost (000)		CONSTRUCTION Materials	Cost (000)		O&M COSTS (000)	
				Fed	Total			Fed	Total		Fed	Total	Fed	Total
49														
50														

Initial Estimates (continued)

Project Name:_____

Table 2. ACTUAL HISTORIC RECORD (up to 1993)
+ FUTURE ESTIMATES (MCACES if available) for the remaining life of project

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION		Cost (000)		PERIODIC NOURISHMENT		Cost (000)		STRUCTURES					EMERGENCY COSTS (PL 84-99)		NAVIGATION MITIGATION to include Section 111		NAVIGATION DISPOSAL (New Work and O&M)	
										CONSTRUCTION			O&M COSTS						
										Materials	Cost (000)		Cost (000)						
		Yards^3 (000)	Borrow Source	Fed	Total	Yards^3 (000)	Borrow Source	Fed	Total		Fed	Total	Fed	Total	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)
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Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION		Cost (000)		PERIODIC NOURISHMENT		Cost (000)		STRUCTURES					EMERGENCY COSTS (PL 84-99)		NAVIGATION MITIGATION to include Section 111		NAVIGATION DISPOSAL (New Work and O&M)	
										CONSTRUCTION			O&M COSTS						
										Materials	Cost (000)		Cost (000)						
		Yards^3 (000)	Borrow Source	Fed	Total	Yards^3 (000)	Borrow Source	Fed	Total		Fed	Total	Fed	Total	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)
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Actual Historic Record (continued)

Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION		Cost (000)		PERIODIC NOURISHMENT		Cost (000)		STRUCTURES					EMERGENCY COSTS (PL 84-99)		NAVIGATION MITIGATION to include Section 111		NAVIGATION DISPOSAL (New Work and O&M)	
										CONSTRUCTION			O&M COSTS						
										Materials	Cost (000)		Cost (000)						
		Yards^3 (000)	Borrow Source	Fed	Total	Yards^3 (000)	Borrow Source	Fed	Total		Fed	Total	Fed	Total	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)	Yards^3 (000)	Cost (000)
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Actual Historic Record (continued)

Project Name:_____

Table 3. ESTIMATED (from Table 1) AND ACTUAL COSTS (Table 2) CONVERTED TO OCTOBER 1993 DOLLARS ($000)

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				EMERGENCY COSTS PL84-99	NAVIGATION MITIGATION	NAVIGATION DISPOSAL
		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ACTUAL COST	to include Section 111 ACTUAL COST	(New Work and O&M) ACTUAL COST
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Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				EMERGENCY COSTS PL84-99	NAVIGATION MITIGATION	NAVIGATION DISPOSAL
		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ACTUAL COST	to include Section 111	(New Work and O&M)
		Fed	Total	Fed	Total	Fed	Total	Fed	Total	Fed	Total	Fed	Total		ACTUAL COST	ACTUAL COST
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Estimated and Actual Costs Converted to October 1993 Dollars (continued)

Project Name:_____

YEAR	ACTUAL YEAR	INITIAL BEACH RESTORATION				PERIODIC NOURISHMENT				STRUCTURES				EMERGENCY COSTS PL84-99	NAVIGATION MITIGATION	NAVIGATION DISPOSAL
		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ESTIMATED		ACTUAL		ACTUAL COST	to include Section 111 ACTUAL COST	(New Work and O&M) ACTUAL COST
		Fed	Total	Fed	Total	Fed	Total	Fed	Total	Fed	Total	Fed	Total			
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47																
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50																

Estimated and Actual Costs Converted to October 1993 Dollars (continued)

Project Name:_____

Table 4. ACTUAL HISTORY OF EACH BEACH NOURISHMENT AND/OR STRUCTURE MODIFICATION

YEAR	ACTUAL YEAR	SIGNIFICANT STORM EVENT OCCURRENCE		OVERFILL RATIO	BERM			DUNE			STRUCTURE MODIFICATION		MEAN HIGH WATER SHORELINE EXTENSION (feet)
		yes	no		Height (feet)	Width (feet)	Length (feet)	Height (feet)	Width (feet)	Length (feet)	yes	no	
1													
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Project Name:_____

YEAR	ACTUAL YEAR	SIGNIFICANT STORM EVENT OCCURRENCE		OVERFILL RATIO	BERM			DUNE			STRUCTURE MODIFICATION		MEAN HIGH WATER SHORELINE EXTENSION (feet)
		yes	no		Height (feet)	Width (feet)	Length (feet)	Height (feet)	Width (feet)	Length (feet)	yes	no	
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Actual History (continued)

APPENDIX B

DIVISION AND DISTRICT POINTS OF CONTACT SHORELINE PROTECTION AND BEACH EROSION CONTROL STUDY

APPENDIX B

DIVISION AND DISTRICT POINTS OF CONTACT
SHORELINE PROTECTION AND BEACH EROSION CONTROL STUDY

Office	Individual(s)	Office Symbol
New England Division	Ms. Catherine LeBlanc	CENED-PL-P
North Atlantic Division	Mr. Edgar Lawson	CENAD-PL-E
New York District	Ms. Lynn Bocamazo	CENAN-PL-F
Philadelphia District	Ms. Christine McVey	CENAP-PL-D
Baltimore District	Mr. John Van Fossen	CENAB-PP-C
Norfolk District	Mr. Mark Mansfield	CENAO-PL-F
South Atlantic Division	Mr. Gerald Melton	CESAD-PD-E
Wilmington District	Mr. Tom Jarrett	CESAW-EN-C
Charleston District	Mr. Larry Casgeel	CESAC-EN-P
Savannah District	Mr. Martin Cooley	CESAS-PD-P
Jacksonville District	Mr. David Schmidt	CESAJ-PD-PC
Mobile District	Ms. Cheryl Ulrich	CESAM-PD-PF
Lower Mississippi Valley Division	Ms. Lexine Cool	CELMV-PD
New Orleans District	Mr. Jay Combe	CELMN-ED-HC
Southwestern Division	none	
Galveston District	Ms. Sheridan Willey Mr. Sid Tanner	CESWG-PL-C
North Central Division	Mr. Charles Johnson	CENCD-PE-ED-TG
Buffalo District	Mr. Tom Bender	CENCB-PE-D
	Mr. Michael Mohr	CENCB-PE-D
Chicago District	Ms. Anne Smith	CENCC-ED-GC
Detroit District	Ms. Carla Fisher	CENCE-CO-OO
North Pacific Division	Mr. Dennis Wagner	CENPD-PE-PL
Alaska District	Mr. Stan Brust	CENPA-EN-CW-PF
South Pacific Division	Mr. Hugh Converse	CESPD-PD-P
Los Angeles District	Mr. Jim Hutchison	CESPL-PD-CS
Pacific Ocean Division	Mr. George Young	CEPOD-ED-PH

APPENDIX C

AUTHORIZING LEGISLATION PERTINENT TO THE SHORELINE PROTECTION AND BEACH EROSION CONTROL PROGRAM

APPENDIX C

AUTHORIZING LEGISLATION PERTINENT TO THE SHORELINE PROTECTION AND BEACH EROSION CONTROL PROGRAM

1. An Act Authorizing General Shoreline Investigations at Federal Expense, PL 79-166, 31 July 1945. This Act established authority for the Beach Erosion Board to pursue a program of general investigation and research and to publish technical papers.

2. Section 14, River and Harbor Act of 1946, PL 79-526, 24 July 1946. Section 14 authorized emergency bank protection works to prevent flood damage to highways, bridge approaches and public works.

3. An Act Authorizing Federal Participation in the Cost of Protecting the Shores of Publicly Owned Property, PL 79-727, 13 August 1946. This Act authorized Federal participation up to one-third of the cost, but not the maintenance, of protecting shores of publicly-owned property.

4. PL 84-71, 15 June 1955. Specifically authorized studies of the coastal and tidal areas of the eastern and southern U.S. with reference to areas where damages had occurred from hurricanes.

5. PL 84-99, 28 June 1955. This Act authorized an emergency fund for flood emergency preparation, flood fighting and rescue operations or for repair or restoration of flood control work threatened or destroyed by flood.

6. PL 84-826, 28 July 1956. Section 1(c) defines periodic beach nourishment as "construction" for the protection of shores, when it is the most suitable and economical remedial measure. Section 1(d) provided for Federal assistance to privately owned shores if there is benefit from public use or from protection of nearby public property.

7. Section 203, River and Harbor Act of 1958, PL 85-500, 3 July 1958. This section added provisions of local cooperation on three hurricane flood protection projects which established an administrative precedent for cost sharing in hurricane projects. Non-Federal interests were required to assume 30 percent of total first costs, including the value of land, easements and rights of way, and operate and maintain the projects.

8. Section 103, River and Harbor Act of 1962, PL 87-874, 23 October 1962.

Shore Protection. Section 103 amended Section 3 of the Act approved 13 August 1946, as amended by the Act approved 28 July 1956 and indicated the extent of Federal participation in the cost of beach erosion and shore protection (50 percent of the construction cost when the beach is publicly owned or used, and 70 percent Federal participation for seashore parks and conservation areas when certain conditions of ownership and use of the beaches are met)--these provisions are modified by the

provisions of PL 99-662.

Small Beach Erosion Projects. Authority for the Secretary of the Army to undertake construction of small beach and shore protection projects was also established under Section 103.

9. PL 88-172, 7 November 1963. Section 1 abolished the Beach Erosion Board and established the Coastal Engineering Research Center.

10. Sections 111 and 215, River and Harbor and Flood Control Act of 1968, PL 90-483, 13 August 1968.

Section 111. This section authorized investigation and construction of projects to prevent or mitigate shore damages resulting from Federal navigation works, at full Federal cost limited to $1 million per project. Amended 17 November 1986 by Sections 915(f) and 940, PL 99-662 which, among other things, increased the limit on Federal costs per project to $2 million.

Section 215. This section authorized reimbursement (including credit against local cooperation requirements) for work performed by non-Federal public bodies after authorization of water resource development projects. Execution of a prior agreement with the Corps was required and reimbursement was not to exceed $1 million for any single project. Amended by Section 913 PL 99-662 and by Section 12, PL 100-676 to increase the limit on reimbursements per project.

11. Sections 112 and 208, River and Harbor and Flood Control Act of 1970, PL 91-611, 31 December 1970.

Section 112. This section increased the limit on Federal costs for small beach erosion projects from $500,000 to $1 million. The annual authorization limit was also raised to $25,000,000. Limits have subsequently been raised further (most recently by PL 99-662).

Section 208. This section authorized discretionary modifications in Federal participation in cost sharing for hurricane protection projects.

12. Section 55, Water Resources Development Act of 1974, PL 93-251, 7 March 1974. Section 55 authorizes technical and engineering assistance to non-Federal public interests in developing shore and streambank erosion.

13. Sections 145 and 156, Water Resources Development Act of 1976, PL 94-587, 22 October 1976.

Section 145. This section authorized the placement of sand obtained from dredging operations on adjacent beaches if requested by the interested state government and in the public interest--with the increased costs paid by local interests. Amended by Section 933, PL 99-662, to allow for Federal funding of 50 Percent of the

increased costs. This section was further amended by Section 207 of PL 102-580 to permit agreements for placement of fill on beaches to be with political subdivisions of a state.

Section 156. This section authorizes the Corps to extend Federal aid in periodic beach nourishment up to 15 years from date of initiation of construction. Amended by Section 934 of PL 99-662 to allow for extension of up to 50 years.

14. Sections 103, 933, 934 and 940, Water Resources Development Act of 1986, PL 99-662, 17 November 1986.

Section 103. Section 103 establishes new non-Federal cost sharing requirements of 35 percent for hurricane and storm damage prevention and 50 percent for separable recreation.

Section 933. This section modifies Section 145 of PL 94-587 to authorize 50 percent Federal cost sharing of the extra costs for using dredged sand from Federal navigation improvements and maintenance efforts for beach nourishment.

Section 934 Section 934 modifies Section 156 of PL 94-587 to authorize the Corps to extend aid in periodic nourishment up to 50 years from the date of initiation of project construction.

Section 940. This section amends Section 111 of PL 90-483 to allow implementation of nonstructural measures to mitigate shore damages resulting from Federal navigation works; to require local interests to operate and maintain Section 111 measures; and to require cost sharing of implementation costs in the same proportion as for the works causing the shore damage.

15. Section 206, Water Resources Development Act of 1992, PL 102-580, 31 October 1992. Under this section, non-Federal interests are authorized to undertake shoreline protection projects on the coastline of the United States, subject to obtaining any permits required pursuant to Federal and State laws in advance of actual construction, and subject to prior approval of the Secretary of the Army.

APPENDIX D

CONGRESSIONALLY AUTHORIZED PROJECTS AND STUDIES

APPENDIX D

CONGRESSIONALLY AUTHORIZED PROJECTS AND STUDIES

District	CWIS	Project
PROJECTS WHICH HAVE BEEN CONSTRUCTED (56)		
NED	0027	Prospect Beach, CT
NED	00275	Seaside Park, CT
NED	39027	Sherwood Island State Park, CT
NED	00461	Quincy Shore Beach, MA
NED	74976	Revere Beach, MA
NED	00464	Winthrop Beach, MA
NED	00515	Hampton Beach, NH
NED	00516	Wallis Sands State Beach, NH
NED	03450	Cliff Walk, RI
New York	05210	Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY (1)
New York	05880	Atlantic Coast of Long Island, Fire Island Inlet & Shore Westerly to Jones Inlet, NY - BEC and Navigation Project
New York	05870	South Shore of Long Island, Fire Island to Montauk Point, Morriches to Shinnecock Reach, NY
New York		South Shore of Long Island, Fire Island to Montauk Point, Southhampton to Beach Hampton Reach, Area of Georgica Pond, NY
New York		Raritan and Sandy H[illegible]k Bay, Madison and Matawan Townships, NJ
New York		Raritan Bay and Sandy Hook Bay, NJ BEC and Hurricane Project, Keansburg and East Keansburg, NJ

Philadelphia		Delaware Coast, DE - Sand Bypass
Philadelphia	76095	Cape May Inlet to Lower Township, NJ
Philadelphia	74963	Great Egg Harbor Inlet and Peck Beach, NJ
Baltimore	13056 59540	Atlantic Coast of Maryland - Ocean City, MD
Norfolk		Virginia Beach (1), VA
Wilmington	13091	Wrightsville Beach, NC
Wilmington	02710	Carolina Beach and Vicinity, NC
Wilmington		Fort Macon, NC
Charleston	13005	Folly Beach, SC
Savannah	58860	Tybee Island, GA - BEC
Jacksonville	74361	Broward County, FL - Segment II
Jacksonville	74361	Broward County and Hillsboro Inlet, FL and Hillsboro Inlet Navigation Project Segment III
Jacksonville	74360	Brevard County, FL - Indialantic/Melbourne
Jacksonville	74360	Brevard County, FL - Cape Canaveral
Jacksonville	74365	Fort Pierce Beach, FL
Jacksonville	74364	Duval County, FL
Jacksonville	14100	Pinellas County, FL - Sand Key Segment
Jacksonville	14100	Pinellas County, FL - Long Key Segment
Jacksonville	14100	Pinellas County, FL - Treasure Island Segment
Jacksonville	19050	Virginia Key and Key Biscayne, FL
Jacksonville	74363	Dade Co, FL (Including Sunny Isles)
Jacksonville	74974	Lee County, FL - Captiva Island segment
Jacksonville	74382	Palm Beach County, FL - Boca Raton Section

Jacksonville	74382	Palm Beach County, FL - Delray Beach Segment
Jacksonville	75099	Palm Beach County, FL - (Palm Beach Island) Lake Worth Inlet Sand Transfer Plant (58)
Jacksonville	79027	Manatee County, FL
Mobile	74567	Harrison County, MS
New Orleans	75315	Grand Isle and Vicinity, LA
Galveston	74979	Corpus Christi Beach, TX
Galveston	74843	Galveston Seawall, TX
Buffalo		Presque Isle, PA
Buffalo	73948	Lakeview Park Cooperative, OH - BEC
Buffalo	07220	Hamlin Beach State Park, NY
Buffalo	13050	Maumee Bay State Park, OH
Buffalo	74202	Point Place, OH
Buffalo	74024	Reno Beach, OH
Los Angeles	22740	Surfside/Sunset, CA
Los Angeles	79214	Oceanside, CA
Los Angeles	14360	Channel Islands Harbor, CA
Los Angeles	74654	Coast of California, Point Mugu to San Pedro Breakwater, CA
Los Angeles	79100	Ventura-Pierpont Area, CA

PROJECTS UNDER CONSTRUCTION OR IN THE PLANNING STAGES: (41)

Under Construction **(1)**

Alaska	12379	Homer Spit Storm Damage Reduction, AK

Authorized/Awaiting Initiation of Construction **(10)**

New York	13052	Atlantic Coast of New York City from Rockaway Inlet to Norton Point (Coney Island Area), NY
New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet (reach 1 (Sea Bright to Ocean Township) Design), NJ
Norfolk	19170	Virginia Beach (2), VA
Wilmington	02710	Area South of Carolina Beach (Kure Beach), NC
Jacksonville	74361	Broward County, FL -Segment I
Jacksonville	14100	Pinellas County, FL - Clearwater Beach Island Segment
Jacksonville	74974	Lee County, FL - Estero Island Segment
Jacksonville	74974	Lee County, FL - Gasparilla Island
Jacksonville	74382	Palm Beach County, FL - South Lake Worth Inlet to Boca Raton Inlet, Ocean Ridge Reach
Jacksonville	74485	Charlotte County, FL - BEC

Preconstruction Engineering Design **(15)**

New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Reach 2 (Asbury Park to Manasquan), NJ
Norfolk	13001	Willoughby Spit and Vicinity, Norfolk, VA
Wilmington	79211	Fort Fisher, NC
Charleston	13041	Myrtle Beach, SC
Jacksonville	13009	Martin County, FL
Jacksonville	13007	Monroe County, FL - BEC
Jacksonville	13006	Nassau County, FL
Jacksonville	13010	St. Johns County, FL
Jacksonville	13043	Indian River County, FL - Sebastian Segment

Jacksonville	13043	Indian River County, FL - Vero Beach Segment
Jacksonville	13058	Sarasota County, FL - BEC Longboat Key & Venice Beach segments
Jacksonville	74382	Palm Beach County, FL - Palm Beach (62) South Lake Worth Inlet Sand Transfer Plant
Mobile	01303	Panama City Beaches, FL
Galveston	53895	Gulf Intracoastal Waterway, Sargent Beach, TX
Chicago	13038	Indiana Shoreline Erosion, IN
Feasibility Level **(5)**		
New York		Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (2), NY
New York	13063	Atlantic Coast of Long Island Jones Inlet to East Rockaway Inlet, Long Beach Island, NY
Norfolk	75213	Sandbridge Beach, VA - HSDR
Savannah	13096	Glynn County, GA
Jacksonville	13045	Brevard County, FL - Shore Protection, Project Review Study
Reconnaisance Level **(10)**		
Wilmington	12835	Dare County Beaches, North Portion, NC
Wilmington	12835	Dare County Beaches, South Portion, NC
Jacksonville	13069	Daytona Beach Shores, FL - Shore protection study
Jacksonville	13136	Collier County, FL
Mobile	12836	Perdido Key Beaches, FL and AL
San Francisco	74723	Ocean Beach, CA
San Francisco		Santa Cruz Harbor and Vicinity, CA
Los Angeles	13081	Pacific Coast Shoreline, Carlsbad, CA

Los Angeles		Oceanside Shoreline, CA
Los Angeles		Malibu Coastal Area, CA

PROJECTS WHICH ARE "CONTINUING AUTHORITY TYPES" (26)

NED	00263	Compo Beach, CT
NED	00278	Silver Beach to Cedar Beach, CT
NED	00264	Cove Island, CT
NED	00262	Calf Pasture Beach Park, CT
NED	00265	Cummings Park, CT
NED	00261	Burial Hill Beach, CT
NED	10005	Guilford Point Beach (Jacobs Beach), CT
NED	00267	Gulf Beach, CT
NED	00268	Hammonasset Beach, CT
NED	00575	Sand Hill Cove Beach, CT
NED	00269	Jennings Beach, CT
NED	93117	Lighthouse Point Park, CT
NED	00272	Middle Beach, CT
NED	00274	Sasco Hill Beach, CT
NED	00272	Short Beach, CT
NED	00279	Southport Beach, CT
NED	86198	Woodmont Shore, CT
NED	00458	North Scituate Beach, MA
NED	00459	Town Beach Plymouth, MA
NED	00463	Wessagussett Beach, MA
NED	00574	Misquamicut Beach, RI
CESPL	74651	Imperial Beach, CA
CESPL	74659	San Diego (Sunset Cliffs), CA
CESPL	74723	Ocean Beach, CA (Navigation Mitigation)
CESPL	22780	Doheny Beach State Park, CA
CESPL		Anaheim Bay Harbor, CA (Navigation Mitigation)

PROJECTS WHICH WERE STUDIED BUT ARE NOW INACTIVE (no cost data on them) (3)

Wilmington		West Onslow Beach, NC
Jacksonville	13021	Flagler County, FL - Shore protection Study
Los Angeles		Las Tunas Beach Park, CA

PROJECTS WHICH ARE NOW DEAUTHORIZED (but were constructed or partially constructed) (there is historical cost data on these) (11)

NED	86044	Lynn-Nahant Beach, MA

Philadelphia		Atlantic City, NJ
Philadelphia	13040	Ocean City, NJ
Philadelphia		Cold Spring Inlet (Cape May City), NJ - BEC
Philadelphia		Delaware Coast, DE - BEC
Charleston	07890	Hunting Island, SC
Jacksonville	22220	Mullet Key, FL - BEC
Jacksonville		Key West, FL
Jacksonville		Naples, FL
Jacksonville	74975	Lido Key, FL - BEC
Jacksonville		San Juan, PR

APPENDIX E

TASK FORCE ON SHORELINE PROTECTION AND BEACH EROSION CONTROL

TASK FORCE ON SHORELINE PROTECTION AND BEACH EROSION CONTROL

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This report defines the scope of the Federal shore protection program over the period 1950-1993 in terms of: the number of projects and types of protective measures; lineal distances of protected shorelines; project costs and expenditures to date; and the quantities of sand used in the restoration and subsequent nourishment of beaches. This report also provides a projection of future costs of constructed protects requiring continued Federal involvement such as beach nourishment as well as an analysis of projected costs for projects which have a strong possibility of being constructed in the next five to ten years (1999 to 2004).

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